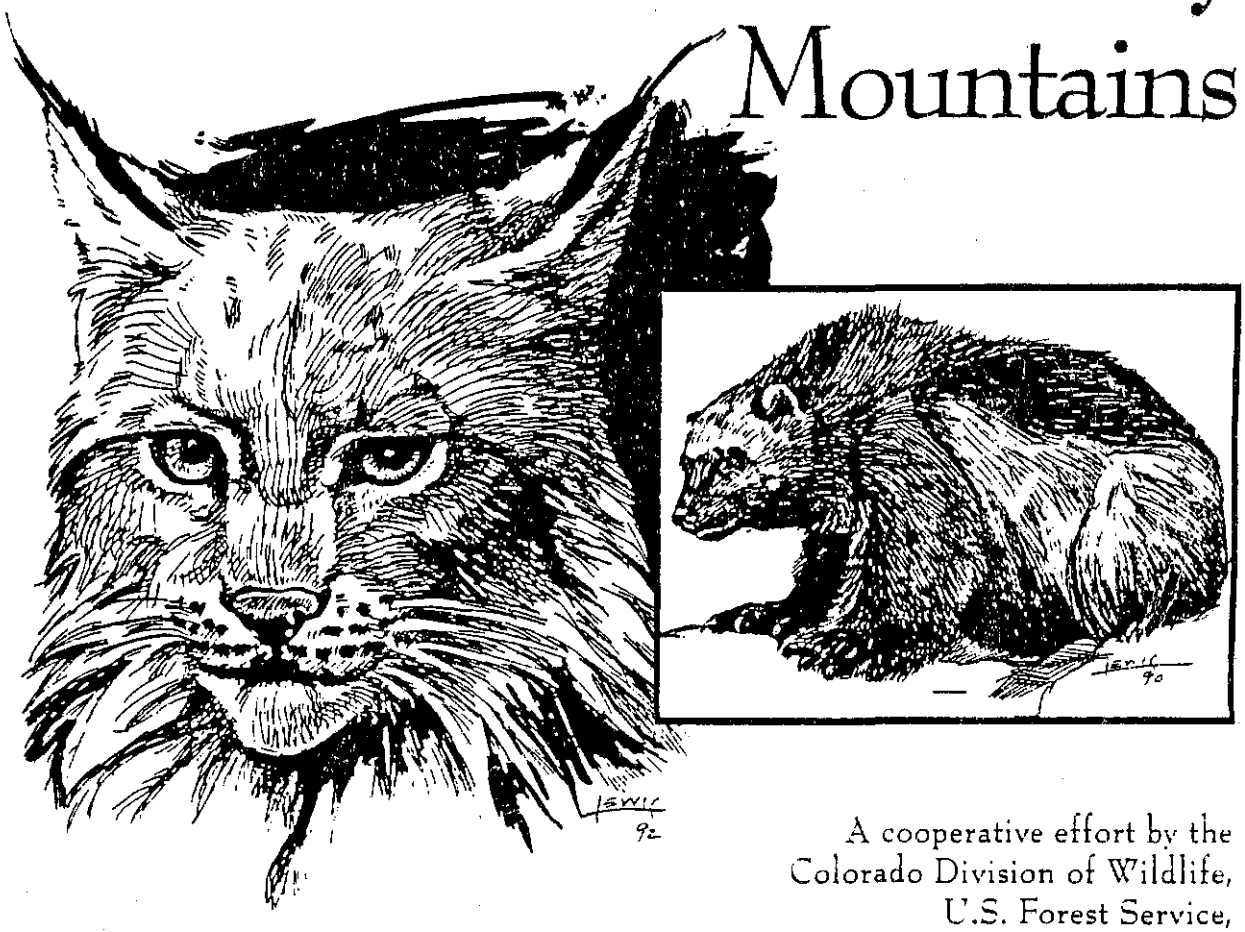
Draft Strategy for the Conservation and Reestablishment of Lynx and Wolverine in the Southern Rocky Mountains



A cooperative effort by the
Colorado Division of Wildlife,
U.S. Forest Service,
National Park Service,
U.S. Fish and Wildlife Service,
New Mexico Game and Fish Department,
and Wyoming Game and Fish Department

DRAFT STRATEGY FOR THE CONSERVATION AND REESTABLISHMENT OF LYNX AND WOLVERINE IN THE SOUTHERN ROCKY MOUNTAINS

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THE SOUTHERN ROCKY MOUNTAINS

Beginning in northern New Mexico, the southern Rocky Mountains extends from the Southern end of the Sangre De Cristos on the east and the southern end of the San Juans in the west. These 2 major ranges merge in the central Rockies of Colorado and run north to Wyoming. There, the habitat, dominated by mountain/canyon complexes with mixed conifer and aspen vegetation, extends north into the Sierra Madre Range and the Medicine Bow Mountains. This area will be referred to as the Southern Rocky Mountains (SRM) in the Conservation Strategy

ABOUT THIS CONSERVATION STRATEGY

A "Conservation Strategy" is not a decision document but a relatively new tool that will help achieve long term conservation of a species. The following Draft Conservation Strategy identifies steps that can be taken to conserve Canada lynx and wolverine in the SRM. This document was cooperatively developed by the Colorado Division of Wildlife; U.S. Forest Service; U.S. Rocky Mountain National Park, and U.S. Fish and Wildlife Service. The document, though principally developed by and for agencies with responsibilities for managing lynx and wolverine and or their habitats, can be used by any agency or person(s) with the authority, responsibility or desire to conserve lynx and wolverine. Federal Agencies can implement this guidance where consistent with existing and future plans that have been subject to review under the National Environmental Policy Act. The State of Colorado, has its own set of procedures that will be applied when implementing this guidance.

Recent formal agreements between State and Federal agencies have resulted in agencies agreeing to work together and participate in the conservation of selected plant and animal species and their habitats to reduce, mitigate, and possibly eliminate the need for their listing under the Endangered Species Act by developing Conservation Agreements and Conservation Strategies (94-SMU-058) (Appendix C). An agreement between the State of Colorado and the USDI Fish and Wildlife Service emphasizes voluntary participation of a broad spectrum of partners to achieve long-term conservation and development of solutions for declining species.

In response to these agreements, State and Federal governments have assembled an interagency technical team, led by the Colorado Division of Wildlife, to develop this Conservation Strategy for lynx and wolverine in the Southern Rocky Mountains. This Conservation Strategy describes the species' current status and suggests steps that need to be taken to establish viable populations of lynx and wolverine in this ecosystem. This Strategy is a document that requires refinement and review over time as our knowledge of these species continues to grow.

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CHAPTER 2. WOLVERINE

EXECUTIVE SUMMARY

Endangered Species

Since life began on this planet many species have come and gone through natural changes in physical and biological conditions. Since these extinctions occur naturally why should we spend money and effort to conserve species that are nearing this end? How do they benefit society if restored? Congress addressed these questions in the preamble of the Endangered Species Act of 1973, "recognizing that endangered species of fish, wildlife, and plants are of aesthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." Congress further stated its intent to protect and conserve the ecosystems and habitats. The State of Colorado has adopted similar protections for species of special concern. The primary force driving the loss of these species is habitat destruction or human exploitation. While we do not know the causes for the decline in lynx (*Lynx canadensis*) and wolverine (*Gulo gulo*) in the Southern Rocky Mountains (SRM) human activity is at least partly responsible. We have the knowledge to conserve and reestablish these species. We also have the responsibility.

History and Distribution

Lynx and Wolverine historically occurred, at low densities, as forest carnivores in the SRM. There have been 12 investigations reported in Colorado since 1979 to document the presence of lynx or wolverine. Although the presence of both species has been suspected but not confirmed, and no viable populations have been found. There have been no field studies in the southern ranges in Wyoming or in New Mexico. Wyoming conducted a survey in 1986 of reported sightings but few of these reports were documented (Reeve et al. 1986). This draft does not include information on the Wyoming and New Mexico portions of the SRM. The final strategy will include a coverage of these areas. Any future decisions regarding lynx or wolverine that affect neighboring states will require further investigation and coordination.

Current Status

At this time the lynx is classified as a federal "candidate" species by the Fish and Wildlife Service. In Colorado the lynx and wolverine are classified as state endangered species and in New Mexico are protected species. Wyoming classifies lynx as Native Species Status Category II and wolverine as Native Species Status Category III (Oakleaf et al. 1996). The Forest Service classifies both lynx and wolverine as "sensitive species."

Conservation Strategy

On July 8, 1997, representatives of the U.S. Forest Service, U.S. Fish and Wildlife Service and the Colorado Division of Wildlife (CDOW) met to discuss a cooperative program for the conservation and reestablishment of lynx and wolverine in Colorado. On August 4, 1997, those agencies plus the National Park Service signed a letter agreeing to jointly prepare "A Candidate Conservation Strategy for Lynx and Wolverine in Colorado." The Colorado Division of Wildlife is the lead agency for these state listed species.

Species Goal

The goal of this strategy is the conservation and reestablishment of lynx and wolverine within their former ranges by establishing populations which reproduce sufficiently to allow emigration into unoccupied suitable habitats. If this is accomplished, it would permit the downlisting of these species by the states from endangered. Both species are considered in this document due to expected economies of scale that will be realized in the habitat assessment, acquisition, and monitoring portions of this strategy. This document could serve as the basis for future recovery efforts in Colorado.

Risks to the Species

We can only speculate on the history of lynx/wolverine populations in Colorado. Some speculate that trapping, hunting, and poisoning played a significant role in population reductions. If so, Amendment 14 approved by the voters of Colorado in 1996 greatly reduced that threat to future populations because it strongly restricts the use of poisons, leghold, kill-type and snare trapping devices in the State of Colorado. Removal of this historical source of mortality would enhance the probability of success for conservation and/or potential future reintroductions of lynx or wolverine. A second primary mortality factor for lynx and or wolverine populations reported from other sites within their distribution is mortality of kittens or kits either through starvation or disturbance during rearing. These are factors that can be addressed by specific management practices. Most of the potential habitat for these species in the SRM occurs on public land with the majority on National Forest System lands. Many National Forest lands in Colorado are designated and managed as wilderness. It is currently not known how much of that area has potential to support lynx and/or wolverine populations.

Habitat Goals for Lynx

The first goal is to describe and map potential habitats for lynx in the SRM. The second goal is to protect those habitats that may be important for whatever lynx may still exist in the state and potential habitats for future reintroduction or reestablishment efforts.

Habitat Evaluation Actions for Lynx

Lynx foraging habitat requirements are inextricably linked to habitat requirements and population distribution of snowshoe hares (*Lepus americanus)* because that species is a staple prey item. Therefore habitats with abundant snowshoe hare populations would be considered the primary criterion for selecting potential locations for lynx reintroductions. The first step in the strategy will be to assess the potential habitats both for foraging and denning potential using GIS vegetation mapping. Key areas will be identified that contain at least the minimum requirements for species survival. The criteria used for this selection will come from the significant body of knowledge that exists for lynx habitats in other regions (Table 1). These same criteria have been used to develop potential habitat management guidelines that will be recommended to land managers until information obtained from monitoring reintroduced individuals suggests changes to those recommendations. Once key blocks of potential habitat are identified, the CDOW intends to conduct two surveys to detect snowshoe hare occurrence and estimate densities to validate or adjust initial habitat assumptions. Data from both surveys will be used to identify the 2 habitats

with the greatest potential to support Colorado lynx. The actual reintroduction sites will be identified from the field surveys and modified or confirmed from advice from a peer review panel of qualified scientists with recognized expertise in lynx ecology and management.

Reestablishment of lynx

Reestablishment of viable lynx populations in Colorado requires reintroductions. A reintroduction would involve assessing potential release sites for habitat suitability, radio-marking lynx prior to release, and intensive monitoring of radio-marked animals. Lynx populations in Canada and Alaska currently are increasing toward peak population levels (Fontana pers. commun. 1997). Lynx selected for reintroduction otherwise would be killed and sold as pelts to be traded as fur. By paying a compensatory price, the CDOW can obtain lynx for reintroduction at a reasonable price *and* increase their chances of survival. When lynx are at the lower end of their population cycle, population levels would be insufficient to provide sufficient animals for reintroduction. Since wild lynx populations cycle every 10 to 12 years, there is a narrow 4- to 5-year window of opportunity to reintroduce lynx in Colorado's most suitable habitats. It is estimated that __ lynx would be needed to be released each year (__ in each of 2 habitats each year) for 2 successive years to establish several viable breeding populations.

Habitat Goals for Wolverine

As with lynx, the first goal is to describe and map potential habitats for wolverine in the SRM (see Wolverine Habitat requirements). The second goal is to protect potential habitat for wolverine that may be important for existing animals and potential future reestablishment or repopulation. Wolverine are expected to fare best in pristine, undeveloped habitats. Colorado's designated wilderness areas could form the primary conservation area nuclei and provide a habitat base for protecting existing critical habitats and remnant individuals.

Habitat Evaluation Actions for Wolverine

Habitat blocks >2000 km^2 (773 mi^2) will be identified and mapped using GIS (Banci 1994). Consideration will be given to areas with little human use such as wilderness, unroaded areas, or areas of low open road/trail densities (see Wolverine Habitat requirements). Again, current knowledge based on studies in Idaho, Montana, Canada and Alaska initially will be used to identify wolverine habitats with the greatest potential for supporting viable populations. Habitat protection and management guidelines will be refined from habitat selection data derived from monitoring reintroduced wolverines. Available habitat models coupled with analysis of GIS maps and advice from scientists with recognized expertise in wolverine ecology and management will comprise the primary criteria for selecting potential wolverine release sites.

Reestablishment of Wolverine

Reintroduction appears to be the only realistic option to reestablish viable populations of wolverine in Colorado. Strategically, wolverine reintroductions would be limited to suitable habitats in Colorado. The reestablishment strategy would include: habitat assessment, reintroduction and radio-marking and intensive monitoring of released animals. Wolverine would be purchased from private trappers in Canada or Alaska. Wolverine that normally would be sold

as pelts, would be bought live from trappers for a compensatory fee. Each wolverine selected for reintroduction would be fitted with a radio-transmitter package before its release into Colorado. Initially, reintroductions would be limited to the 2 sites that are judged to have the greatest likelihood of supporting wolverine populations. A minimum of __ wolverines should be released into each site for 2 successive years.

Species Monitoring

Radio-marked lynx and wolverines would be intensively monitored by frequent relocations both from the air and the ground. Recorded data would include habitat selection patterns, seasonal home ranges, reproductive success, survival, and probable cause of death when mortalities are detected. This information would be evaluated critically to determine if additional releases of these species into unoccupied habitats is warranted before additional releases are attempted.

Revision

Any strategies for conserving lynx and wolverine in the SRM must be regarded as tentative because very little is known about their specific ecology and habitat requirements in the SRM. As the body of knowledge increases and new information is gained from post-release monitoring of both lynx and wolverine, the Conservation Strategy would be revised. Formal lynx and wolverine status reviews would be scheduled periodically (e.g., annually) by the Lynx and Wolverine Conservation Strategy Team to revise the lynx/wolverine Conservation Strategy as needed.

Budget

A draft budget is included in Appendix B. It is estimated that the cost to complete the first 3 years of this Conservation Strategy could approximate $2.5 million. The Division of Wildlife has committed to funding $700,000, leaving $1.8 million to be acquired from other sources.

Habitat Protection

Following the pre-release habitat suitability surveys, it will be necessary to develop interim guidelines to delineate, preserve and protect lynx and wolverine habitats on public lands that are deemed critical to the conservation of these species. These interim habitat protection guidelines periodically would be revised as additional information surfaces from the post-release monitoring of radio-marked individuals. Guidelines will be based on the best scientific and economic information available; will conform to existing laws and regulations; and will be subjected to further peer and public review prior to implementation. These guidelines will be developed and amended into this document at a later date subject to concurrence by all signatories.

CHAPTER 1. LYNX

CONSERVATION STRATEGY FOR LYNX

Interagency Memorandum of Agreement

On July 8, 1997, representatives of the U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS) and the Colorado Division of Wildlife met to discuss a cooperative program for the conservation and reestablishment of lynx and wolverine in Colorado. On August 4, 1997, those agencies plus the U.S. National Park Service Rocky Mountain National Park signed a letter agreeing to jointly prepare "A Candidate Conservation Strategy for Lynx and Wolverine in Colorado" (Appendix D).

History and Distribution

Lynx were native to the SRM (Fig. 1). In Colorado there are only about 18 documented records of lynx in the state (Byrne 1997). There are 4 historical records in the SRM part of Wyoming and none in New Mexico (Reeve et al. 1986). It is generally assumed that lynx have always been rare in Colorado. From 1878 to 1935, there are 14 documented records of lynx. After 1935, there are only 4 positive records of lynx (one record, the Vail lynx, refers to 2 lynx being trapped and one killed). All of these records occurred during the period January 1968 to February 1973 and were taken in the central part of the state, within a 35-mile radius of Hoosier Pass south of Breckenridge. The last known lynx in Colorado was illegally trapped on the Vail ski area in February 1973. The CDOW maintains a database of lynx records and observations. Presently there are 18 "A" or positive records, 55 "B" or probable observations, and 64 "C" or possible observations. There are 5 known specimens of lynx available for inspection, the 4 lynx harvested after January 1968 and a specimen at the Canon City museum of a lynx collected by Dall DeWeese on the South Fork of the White River in 1905. This last lynx is not in the Colorado database but will be added in the next update.

The primary ranges of the lynx in North America is found in the boreal forests of Alaska and Canada. The high-elevation montane forests of the Cascade Range in Washington and Oregon, and the Southern Rocky Mountains represent the southern margin of the lynx's geographic range (Koehler and Aubry 1994). Although historically rare in Colorado, Oregon, Utah, and Wyoming, lynx have occurred in 1) the Thompson-Okanogan Highlands of north-central Washington, 2) the northern Rocky Mountain forest lands of southwestern Montana and northwestern Wyoming, and 3) the Shining Mountains of northwestern Montana and northern Idaho (Koehler and Aubry 1994).

Recent Investigations

Since 1979, 12 investigations have been conducted in Colorado with the goal of trying to document the presence of lynx or wolverine (Appendix E). No field investigations have been conducted in those portions of the former lynx range located in southern Wyoming (Oakleaf pers. commun. 1997). After intensive efforts using snowtracking (5,833.5 mi), hair snags (62 locations), remote cameras (110 locations) and snares (686 trap nights), only 11 sets of tracks that *appeared to have a high probability* of being lynx were found. The CDOW has offered a

$500 reward for any positive information on lynx since 1993 and has not received any. There have not been any road kills or accidental trapping or shooting of lynx/wolverines reported since 1973. The CDOW has concluded that *if* any lynx remain in Colorado their numbers are so small that they do not represent a viable population, and are not detectable by known census methods. It is quite possible that lynx have been extirpated from Colorado (Byrne pers. commun. 1997).

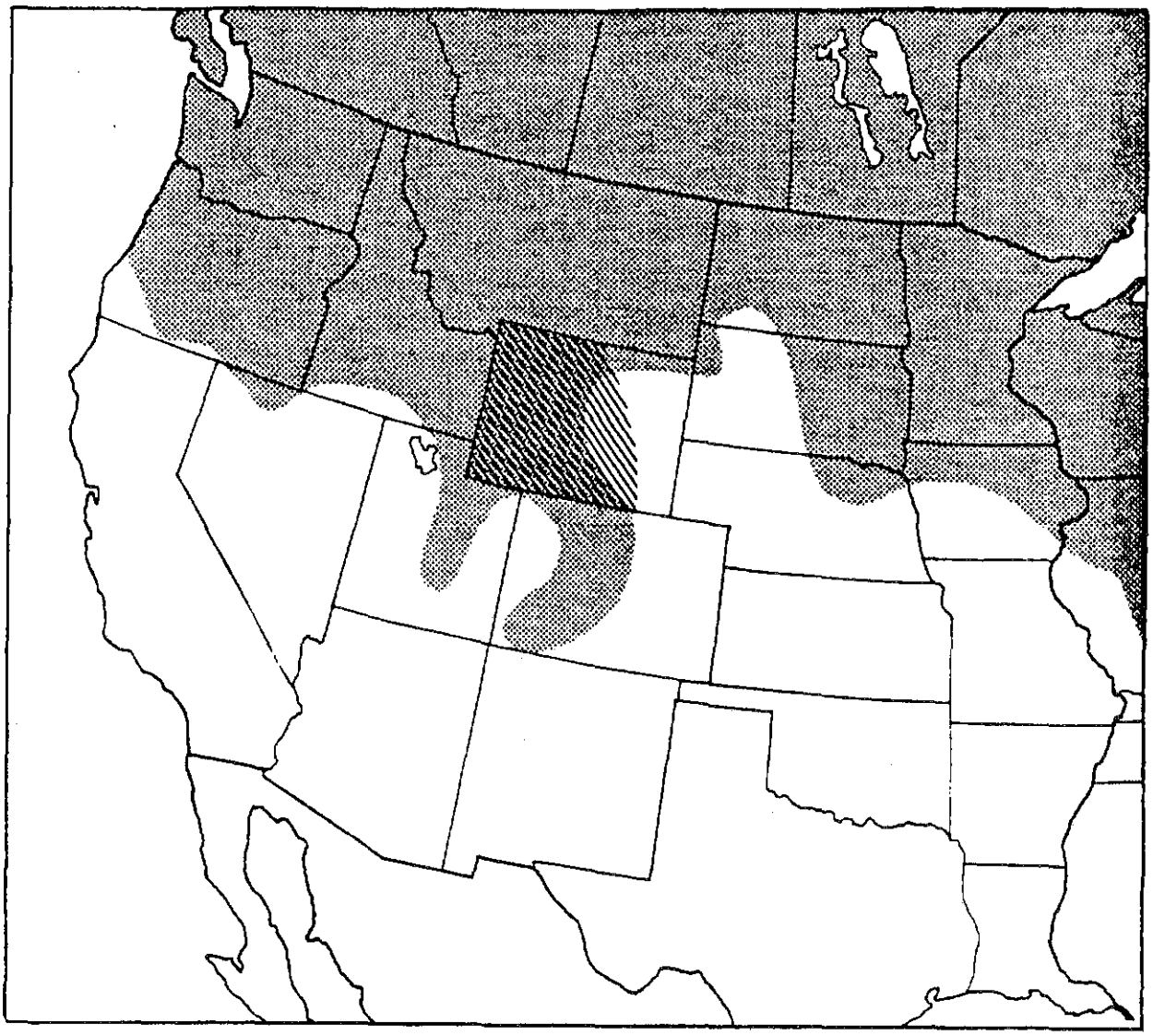


Figure 1. Distribution map of lynx in the western United States and southwestern Canada (stippled shading after Hall and Kelson 1959) with the Wyoming distribution emphasized (diagonal shading after Long 1965).

Current Management Status in Colorado

- The season on lynx was closed by the Colorado Wildlife Commission (CWC) on March 25, 1971.
- Lynx were designated a *state* endangered species in January 1976 by the CWC. This protects the species from being killed or possessed, but does not protect the habitat.

- A petition to list lynx as an endangered species in the conterminous United States was filed in Washington state; this petition was denied by the USFWS in 1992.
- The U.S. Forest Service designated lynx as a sensitive species in 1993. This means the species and its habitat are given special consideration for all management planning efforts.
- The USFWS was recently required by a Federal District Court order to review their decision not to list lynx. The USFWS reviewed their decision and issued a finding of "warranted but precluded" in May 1997 (Federal Register 1997). The lynx's federal status was changed to "candidate" at this time.
- Amendment 14 approved by the voters of Colorado in November 1996 greatly restricted the use of poisons and of leghold, kill-type and snare trapping devices in the State of Colorado.

Taxonomy

Lynx are a circumpolar species that is recognized here as a sub genus of Order Carnivora, family Felidae, Subfamily Felinae, genus *Felis*, subgenus *Lynx*. The subgenus *Lynx*, then includes two extant species; *F. lynx* and *F. rufus.*, and at least eight subspecies are recognized (Cobert 1978). The eight presumptive lynx subspecies and their respective approximate range are as follows: *F. l. lynx*, boreal Europe, Asia and the Carpathian Mountains; *F. l. canadensis*, boreal North America; *F. l. pardina*, Iberian Peninsula; *F. l. isabelalina*, Mountains of central and eastern Asia; *F. l. subsolanus*, Newfoundland; *F. l. sardiniae*, Sardinia; *F. l. kozlovi*, Buryatskaya U.S.S.R.; *F. l. stroganovi*, Lake Baikal region, U.S.S.R." Tumlison (1987). Wilson and Reeder (1993) place the distribution of *Lynx canadensis* as the "Taiga zone of North America, south to C Utah and SW Colorado; NE Nebraska, S Indiana and West Virginia (USA)."

Species Ecology

Morphology

Lynx are medium sized cats with long legs, large feet, and short tails. Their paws are larger than the bobcats and can support four times as much weight on snow. Males are slightly larger than females. The tail is short and completely black. The ears have long (approx. 5cm or 2 in.) blackish tufts, and the face has a pronounced ruff. The fur is grey-brown, long, dense, soft and fine. Total length is 670-1067 mm (26-42 in.); weight 5-15 kg (2.27-6.80 lbs) (Fitzgerald et al. 1994).

Home Ranges

Lynx home ranges vary from 8 to several hundred km^2 (3 to several hundred mi^2). Largest ranges were from animals colonizing northeastern Minnesota (Mech 1980). Mech (1980) reported home ranges of females overlapped, those of the males did not. He found little overlap of male and female home ranges. Home ranges in Colorado are likely configured on existing geographical and physiographical features in relation to upper montane and subalpine forest ecosystems and relative prey availability. This prey density can cause fluctuations in Lynx densities from 1-35 lynx per 100 km^2 (386 mi^2) (Kohler and Aubry 1994). Lynx hunt mostly on the ground. They bed under ledges, trees, deadfalls, or in caves. In severe weather they bed in thick evergreen cover.

Food Habits

Snowshoe hare, often make up 80% of lynx diets (Brand et al. 1976, More 1976, Nellis et al. 1972, Saunders 1963*b*). Blue grouse (*Dendragopus obscurus)*, white-tailed ptarmigan (*Lagopus leucurus)*, red squirrels (*Tamiasciurus hudsonicus)*, voles *(Microtus* spp.), ground squirrels (*Citellus* spp.), beaver (*Castor canandensis*), muskrat (*Ondatra zibethicus*), mule deer (*Odocoileus hemionus)*, caribou (*Rangifer tarandus*), and moose (*Alces alces*) are also eaten. Most ungulate remains in the diet represent carrion. Lynx require 4 snowshoe hare/week, caching them when plentiful (Brand et al. 1976, Nellis and Keith 1968). Brand et al. (1976) estimated lynx dietary intake averaged 960 grams/day, with prey capture success approaching 36%. Whether hare and lynx are cyclic in the Rocky Mountains is unclear. Dolbeer and Clark (1975) did not report marked fluctuations in hares in Utah and Colorado. Greater diversity of prey may occur in the SRM due to reduced numbers of snowshoe hare and the selection of alternative prey.

Reproduction

Lynx breed from March to May in Canada (Brand and Keith 1979, Nellis et al. 1972). Gestation takes about 9 weeks, with 1 litter produced per year (Brand et al. 1976, Saunders 1963*a*). Litter size ranges from 1 to 6 (average 3) (Brand and Keith 1979, Tumlison 1987). Females rear the litter. Young disperse in the fall or following spring. Some females breed as yearlings (Brand and Keith 1979, Nava 1970, Parker et al. 1983). Saunders (1964) describes development of the young. Snowshoe hare and lynx have 10-year cycles of abundance and decline in Canada (Quinn and Parker 1987). Low snowshoe hare populations lead to reduced breeding by females and increased mortality of kittens. Kitten mortality exceeds 90% under such conditions (Brand and Keith 1979, Slough and Mowat 1996*a*).

Mortality Factors

Lynx have been killed by gray wolves (*Canis lupus*) mountain lions (*Felis concolor*) and wolverines; adult males have killed kittens (Quinn and Parker 1987). Heaviest mortality is associated with kitten losses from starvation, and harvest by humans. Kitten loss during low hare population years may be significant (Slough and Mowat 1996*a*).

SUMMARY OF FACTORS AFFECTING THE SPECIES

Lynx populations in Colorado represent the extreme southern edge of their range (U.S. Fish and Wildl. Serv. 1997) with lynx habitat in Colorado consisting of mixed lodgepole pine (*Pinus contorta*), spruce-fir and aspen forests (Weaver 1997). Wyoming's Red Desert may act as a major barrier that reduces opportunities for the immigration and emigration of the species, possibly isolating lynx in Colorado from other populations in the northern Rockies (Thompson and Halfpenny 1989). It appears lynx occurred historically in Colorado at low densities and are currently believed to be extremely rare and may be extirpated. If present, they are at such low density levels thay do not represent a viable population.

1. The present or threatened destruction, modification, or curtailment of the species' range or habitat.

Isolation increases the susceptibility of lynx to human-caused threats, natural stochastic events, and effects of a genetic bottleneck (Stolenzenburg 1991). The loss of suitable habitats reduces the potential for population growth or recolonization (Weaver 1993).

A major influential factor affecting lynx and snowshoe hare habitat is human alteration of the abundance, species composition, successional stages, and fragmentation of forest vegetation (U.S. Fish and Wildl. Serv. 1997). Colorado's landscape is naturally fragmented by the interior mountain ranges that separate forested areas with rocky ridges and cirques. In addition, considerable fragmentation has occurred as a result of the tremedous human population growth that has taken place in this region. The natural fragmentation has been compounded by roads, highways, ski areas and reservoirs that may create barriers to use by lynx.

Snowshoe hares comprise 80% of the lynx diet and may be the only prey to provide the quality food necessary to support lynx populations in central Alberta (Brand and Keith 1979). Quade (1996), however, argues that predator populations at lower latitudes are less specialized and have a wider prey base as abundance and diversity increase, and as more niches and habitat types become available. Forestry practices can be beneficial or detrimental depending on the manner and extent in which they are conducted. Timber harvest can be used to achieve the early successional forest stages preferred by snowshoe hares in northern Maine (Monthey 1986). However, excessive or indiscriminant tree harvest can eliminate the mosaic of habitats necessary for lynx survival, including late forest successional stages needed for denning and adequate cover in travel lanes between successional stages (U.S. Fish and Wildl. Serv. 1997). Benefits from timber harvest would require 20-40 years to achieve desired results. Lynx avoid large openings that lack the cover necessary for snowshoe hares as well as for the lynx itself (Koehler and Aubry 1994).

In the SRM, the majority of lynx habitat occurs on public lands. Currently there are few activities on some public forested lands (especially in Colorado) generating the early successional forest stands important to snowshoe hares and lynx (U.S. Fish and Wildl. Serv. 1997). Dolbeer and Clark (1975) reported mature and old growth spruce-fir forest on north facing slopes with an abundance of seedling and sapling trees had the highest snowshoe hare densities in central Colorado. Since 1975, National Forests in the Rocky Mountain region have identified 60% of the region as forested land. Approximately 4.2 million acres are Engelmann spruce (*Picea engelmanni)* and subalpine fir (*Abies lasiocarpa*). Additionally there are 2.8 million acres of lodgepole pine, 1.3 million acres of Douglas fir (*Pseudotsuga menzeisii),* 2.1 million acres of ponderosa pine (*Pinus ponderosa)* and 2.1 million acres of aspen (*Populus tremuloides*) (Rocky Mountain Region, Regional Guide). The majority of these forests are older forests in excess of 100 years of age. Approximately 77% of the spruce/fir stands average between the ages of 80 and 220 years old. Most stands have many individual trees exceeding 220 years in age and they can reach up to 500 years in age. These old growth stands are usually characterized by trees of diverse age classes with Englemann spruce being the oldest and subalpine fir the youngest trees in these stands. Lodgepole pine trees, in the form of 20-40 year old dense stands, were a common component of the lower elevation spruce-fir forests in central Colorado(Andrews 1992). One current hypothesis is that the lack of adequate snowshoe hare habitat in southern latitudes may be partially a result of fire suppression during the past 50 years, which has allowed forests to mature (Koehler 1990). Many, if not most, lodgepole pine forests in Colorado regenerated between the late 1800s and the early 1900s due to their ecological condition providing fuel for catastrophic fire. This was coupled with abundant fire-ignition sources (lightning and human) within the landscapes (Buell

1997). In Colorado, clearing of public and private forests for urbanization, ski areas, and private agriculture has degraded or reduced the available suitable lynx habitat and reduced the prey base. Roads into forest ecosystems have also increased human disturbance and the likelihood of accidental trapping, shooting, and highway mortality (Thompson and Halfpenny 1991).

2. Overutilization for commercial, recreational, scientific, or education purposes.

Human-induced mortality is the most important mortality factor for lynx populations when they are in the declining part of their cycle, with trapping mortality shown to be entirely additive (i.e., in addition to natural mortality) rather than compensatory (taking the place of natural mortality) (Ward and Krebs 1985). However, the immediacy of the threat of trapping is nonimminent because all States within the current range of lynx in the contiguous United States either have severely restricted or closed their lynx harvest seasons (U.S. Fish and Wildl. Serv. 1997). Montana allows the trapping of less than 5 lynx per year. In Colorado the taking of lynx has been prohibited since March 1971.

3. Disease or predation.

Disease and predation are not known to be factors directly threatening Canada lynx populations (U.S. Fish and Wildl. Serv. 1997). However, predators of snowshoe hares in southern ecosystems include coyote (*Canis latrans*), bobcat (*Lynx rufus*), red fox (*Vulpes vulpes*), and several species of hawks and owls (Koehler and Aubry 1994). Wolves, mountain lions and coyotes have been documented to kill lynx.

4. Inadequacy of existing regulatory mechanisms.

The lynx was classified as endangered by the State of Colorado in 1976 and the taking of lynx has been prohibited since 1971 (J. Sheppard, pers. commun. 1997). Since 1996 the use of poisons, leghold, kill-type and snare trapping devices has been greatly restricted. This will enhance the possibility of survival of the species by removing the possibility of accidental capture. The U.S. Forest Service classifies lynx as a sensitive species in the Rocky Mountain Region. This designation serves as an early alert to develop and implement conservation strategies and insure that Forest Service activities do not cause this species to move toward federal listing. The U.S. Fish and Wildlife Service has found that listing the lynx in the contiguous United States is "warranted," but is "precluded" by work on other species having a higher priority for listing. This "warranted but precluded" finding automatically elevates the lynx to candidate species status (U.S. Fish and Wildl. Serv. 1997).

5. Other natural or manmade factors affecting the species' continued existence.

Human access into remote areas may have direct and indirect impacts on lynx populations and this access has increased over the last several decades because of increased construction of roads and trails and the growing popularity of snowmobiles and other off-road vehicles (U.S. Fish and Wildl. Serv. 1997). Increased human access into forests may be a significant threat to lynx because the likelihood of lynx encountering people increases, thus resulting in more lynx deaths from intentional and unintentional shooting, trapping, and being hit by automobiles (Hatler 1988, Thiel and Hallowell 1988, Brittell et al. 1989, Koehler and Brittell 1990, Brocke et al. 1991, Andrews 1992). Wide-ranging species are impacted by the accompanying effects of fragmentation, particularly increased open road densities (Litvaitis 1993), major highways and subdivisions.

In addition to increasing the accessibility of historically remote forest habitat, roads themselves fragment habitat and increase the probability of mortalities from vehicle collisions (U.S. Fish and Wildl. Serv. 1997). Lynx are believed to be susceptible to anthropogenic disturbances during the denning period and it is believed that females will move kittens in response to disturbance, thereby increasing the chances of mortality (Koehler and Aubry 1994). Lynx are specialized deep snow predators, an adaptation that permits year-round high elevation residency. Historically, bobcat and coyotes have not been able to compete with lynx in areas that receive deep snow cover. However, snowmobile or cross country ski trails and roads that are maintained for winter recreation and forest management activities are now enabling increasing numbers of coyotes and bobcats to access lynx habitat, which may be especially detrimental to lynx during the stressful winter period (Koehler and Aubry 1994).

LYNX CONSERVATION STRATEGY FOR COLORADO

Introduction of lynx from populations in Canada and/or Alaska has the best potential for restoring a viable population of this forest carnivore to the state and for removing them from Colorado's endangered species list. Lynx transplants have been attempted only twice, in the Adirondacks of New York and Ontario. The Adirondack reintroduction results were, out of 50 lynx, 6 were killed on roads, 2 were shot, and 3 young died from natural causes (Brocke et al. 1992). To ensure the best chance of a successful reintroduction in Colorado, the potential habitat for lynx should be delineated using knowledge from studies in the western United States and Canada. Dr. John Weaver has proposed to organize a Lynx Advisory Team (LAT) (Appendix G), which would peer review the reintroduction strategy and could make recommendations on the numerous logistical options available (Weaver 1997). This team has not been finalized and will contain members of land managment agencies, ecologists and species specific scientists. If the minimum habitat components are not found in the habitat suitability analysis, no reintroduction will take place.

Species Goals and Objectives

Overall Goal: To reestablish the lynx to a viable population in the SRM.

Objectives:

1. Identify potential reintroduction sites through habitat assesment process.
2. Select __ sites for release of reintroduced animals.
3. Reintroduce lynx into suitable selected sites in order to establish a viable metapopulation in Colorado.
4. To downlist the state listing of lynx. To do so, __ self-sustaining viable populations of __ animals will need to be established that are stable or increasing.

Reintroduction is an ambitious undertaking in light of many unknowns. Specific information about lynx in Colorado is very limited. It is recommended that the LAT peer review be utilized to review the conservation strategy and provide recommendations on the numerous options involved in the reintroduction. Post-release monitoring is necessary to provide the information needed on habitat preference, denning sites, linkage zones, density and productivity of lynx, and potential reaction to human occurances/disturbances in Colorado. Because assumptions made before release could be incorrect, flexibility of objectives needs to be understood.

A pragmatic goal for Colorado would be a population of __ lynx to ensure viability. This must be a flexible goal since the detailed mapping of suitable habitat has not been done. Once habitat is better delineated, a potential population can be predicted based on food availability and home range sizes. Post-release monitoring of lynx will further refine our knowledge of the habitat capabilities.

Lynx Habitat Requirements

Lynx require a landscape mosaic of forest habitats for foraging, denning, and travel. A dominant forest community with low topographic relief and stands of varying ages are preferred lynx habitats in Canada and Alaska (Koehler and Aubry 1994). In the mountains of the western states, including Colorado, Engelmann spruce, subalpine fir, aspen, and lodgepole pine are likely the dominant components of their preferred habitats; however, these forested areas are naturally fragmented patchy. Furthermore, early-successional forests created by fire, windthrow, disease, and timber harvesting, create conditions favorable for such forest habitats. Uneven-aged stands with relatively open canopies and well-developed understories that are favorable habitat for snowshoe hares, are considered ideal (Quinn and Parker 1987).

A general broad distribution of potential Colorado lynx habitat, based on Kuchler's alpine and montane vegetation types, in the western mountains shows that lynx in Colorado are on the southern periphery of lynx range and disjunct from the northern rockies ecosystem (Roloff 1995*a*, 1995*b*; Fig. 2). Koehler (1989, 1990), and Koehler et al. (1979) describe the importance that dense, immature lodgepole pine stands in north central Washington play in the overall landscape of subalpine forests. Mature, dense Engelmann spruce/fir forest provides long-term cover and forage opportunties for both lynx and snowshoe hare. Regenerating (20-40 years old) lodgepole pine or douglas-fir provides short- to moderate-term cover and forage for lynx, but primarily provides high-density food for snowshoe hare which allows local populations to increase. Together, adjacent in a landscape, these two forest types and situations provide long-term habitat for the higher abundances of snowshoe hare.

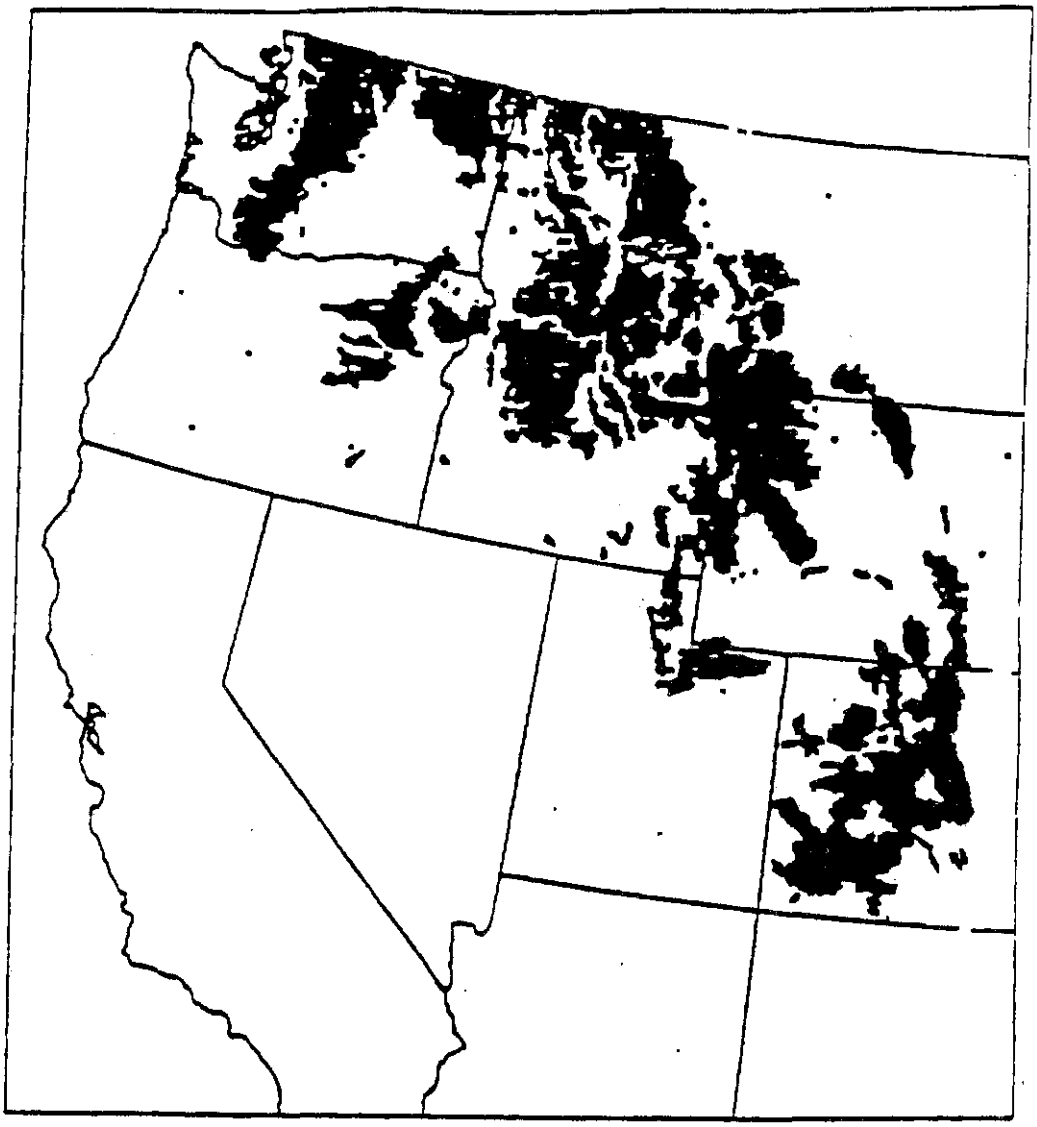
Fitzgerald et al. 1994) speculate that lynx in Colorado would prefer dense spruce-fir stands in association with rock outcrops and large boulders. Similarly, Weaver (1997) and Dolber and Clark (1975) suggested that mature Englemann spruce/subalpine fir and lodgepole pine mixed with spruce/fir might be the preferred habitat of lynx in Colorado. They suggested that the dry understory associated with lodgepole pine in Colorado is exceptionally sterile of browse plants compared to the northern Rockies which have a heavy understory of huckleberry (*Vaccinium* spp.) and pachistima (*Pachistima myrsinites).* They speculated that natural and human caused fragmentation of Colorado landscapes may be the limiting factor affecting lynx reestablishment.

Foraging Habitat

Considering that snowshoe hare are the principal prey of lynx, (alternate prey being red squirrel, grouse, etc.), emphasis should be placed on habitats having adequate densities of this prey. Extensiveness of foraging habitat, including some minimum density of snowshoe hares, should be considered as one of the essential components before a given release site would be selected.

Snowshoe hare habitat requirements vary according to Pietz and Tester (1983) and Poole et al. (1994). The vegetation must be of a certain type and size diameter and within a certain height

Potential Lynx Habitat
Kuchler's Alpine and Montane Boreal Vegetation Classification



Vegetation types included:

Silver fir-Douglas-fir Forest	Grand fir-Douglas-fir Forest	Spruce-fir-Douglas-fir Forest
Fir-hemlock Forest	Western Spruce-fir Forest	Southwestern Spruce-fir Forest
Douglas-fir Forest	Pine-Douglas-fir Forest	Alpine Meadows and Barren

Figure 2. Distribution of lynx habitat in the western mountains of the United States based on potential vegetation.

above the surface. Depending on understory plant associations of various habitat types, such characteristics may be found in early-successional or late-successional stages. Productivity of the habitat may be high but relatively brief on sites of rapid succession (dense regeneration stands of

lodgepole pine seedlings/saplings), or it may be lower but longer on sites of stable forests (mature stands of Engelmann spruce/subalpine fir) (Weaver 1997). More specifically in Washington, Koehler (1990) found a correlation between hare densities and stands with tree and shrub stems that were less than 2.5 cm (1 in.) in diameter at 1 to 1.5 meters (39 to 45 in.) in height (DBH). Intensive use involved 20-year-old stands with up to 15,840 stems/ha (6,412 stems/ac). Foraging habitat evaluations need to consider summer conditions verses winter condition, e.g. ground cover provides little forage value for snowshoe hare in winter when covered by 6 feet of snow. In winter, vegetative abundance and dense cover could be a limiting factor for snowshoe hare in Colorado. Field observations and photographs show that overall cover is likely reduced between summer and winter in patchy, multistoried, unevened-aged conifer stands, especially in relatively open canopied (less than 70%) forest stands. In regenerating lodgepole pine where tree crowns touch the ground, provide more consistent cover and forage at the 6-foot snow level (Buell pers. commun.).

O'Donoghue (1994) and O'Donoghue and Stuart (1993) discuss snowshoe hare juveniles (leverts) in the nest (spring/summer) being preyed on by red squirrels in magnitudes between 30 and 70% of the litter. This predation is likely in addition to predation of snowshoe hare (various age-classes) by American marten, red fox, goshawk (*Accipiter gentillis)*, great horned owl (*Bubo virginianus*), bobcat and coyote. Red squirrel and marten are common in Colorado, as elsewhere, in mature forest conditions, thus in relation to lynx and snowshoe hare, red squirrel may likely be potential predators of snowshoe hare leverts in mature Engelmann spruce and subalpine fir. Higher snowshoe hare abundances are more likely to be maintained where landscape forest conditions are a mosaic of mature spruce/fir and regenerating lodgepole pine, with more snowshoe hare available for lynx (Koehler and Aubry, 1994). Colorado may have lower natality due to delayed onset of breeding and fewer litters than cyclic snowshoe hares in the northern boreal forests of Alaska and Canada in the increase phase (Weaver 1997).

Denning Habitat

Mature forest habitats that contain large woody debris, such as downed timber, upturned stumps, root tangles, shrub thickets, or similar dense vegetation provide security and thermal cover for raising kittens (Koehler and Aubry 1994, Quade 1996). Other features include minimal human disturbance and proximity to forest foraging habitat (see above), and northerly aspects (Brittell et al. 1989 and Koehler 1990). In addition, the juxtaposition of denning habitat and foraging habitat is an important consideration as it relates to travel time and energy expenditure.

Travel Habitat

Travel corridors are important in providing access to alternate foraging areas and alternate den sites that permit females to move kittens to areas where prey are more abundant or to avoid disturbance (Koehler and Brittell 1990). Lynx require cover for security and stalking of prey and to avoid large open areas (tend not to cross open areas >100 m in diameter) (Koehler 1990). Suitable travel cover consists of coniferous or deciduous vegetation >2 m in height with a closed canopy (Koehler and Aubry 1994). Lynx are known to move long distances (Koehler et al. 1979) but human developments may discourage use and disrupt their movements. Roads may increase the vulnerability of lynx to illegal take and to road kill (Brocke et al. 1990). Connectivity is an important habitat feature for long-term "minimum viable population" considerations.

Numerous studies have described the components of these habitat types (Table 1).

Table 1. Recommendations for consideration in developing management guidance for lynx in Colorado.

Description	Location of Study	Reference
FORAGING HABITAT REFERENCES		
Early successional forests where snowshoe hares are plentiful are the habitats that lynx favor for hunting. Such forests may result from fires (Bailey et al. 1986; Fox 1978; Keith and Surrendi 1971; Koehler 1990, 1991), timber harvesting (Conroy et al. 1979; Koehler 1990, 1991; Litvaitis et al. 1985; Monthey 1986; Parker et al. 1983; Wolfe et al. 1982), or windthrow and disease (Koehler and Brittel 1990).		
Snowshoe hare foraging habitats:		
Stem densities – 15,840 tree and shrub stem/ha (6,414/acre).	NC Washington	Koehler 1990
Stem densities – 22,027 tree and shrub stem/ha (8,918/acre).	Alaska	Wolff 1980
Stem densities – 9,000 conifer stem/ha (3,644/acre).	Nova Scotia	Wolff 1980
Stem densities – 16,000 tree and shrub stem/ha (6,478/acre).	Maine	Litvaitis et al. 1985
Stem densities – 6,000-31,667 tree and shrub stem/ha (2,429-12,820/acre).	NC. Washington	Koehler 1990
Favorable habitat for snowshoe hares, i.e. open canopies, well-developed understories.	Ontario	Quinn and Parker 1987
Mosaic of early successional habitats with high snowshoe hare density.	Washington	Wash. State Dep. of Nat. Resour. 1996
		Koehler and Aubry 1994
Englemann spruce/sub-alpine fir or spruce/fir mixed w/lodgepole pine with young subalpine fir providing cover near ground surface.	Montana	Weaver 1997
Recommendations for consideration in development of guidance for Colorado foraging habitat (from Idaho Conservation Strategy, Roloff 1995)		
Foraging - Stand scale (1-200+ ha/1-500+ acres)		
• Understory species composition	Optimum = coniferous understory Sub-optimum = coniferous and deciduous mix Poor (but used) = deciduous understory	
• Understory stem density	Optimum for Colorado is currently unknown.	
Maximize conifer and shrub stem densities to the high magnitude.		
• Horizontal and vertical cover less than 3 m (6 ft) tall (summer habitat). Greater than 25% winter horizontal cover of live plants 0-3 m (0-6 ft) tall. Greater than 10% winter vertical cover of live, palatable browse species for hares 0-3 m (0-6 ft) tall. Greater than 40% horizontal and vertical cover of live and dead structures 0-3 m (0-6 ft) tall.		
• Understory height Sufficient quantities of stems must be present in varying height strata to account for differences in foraging accessibility (by snowshoe hares) with differing snow depths.		
Foraging - Sub-drainage scale (sub-drainage ranging between 2,348 and 24,900 ha/5,800 and 61,500 acres)		
• Maintain a mosaic of forest structural stages ranging from dense, mature spruce/fir to mixed conifer to early seral lodgepole pine or Douglas-fir.		
• Maintain and enhance foraging spatial arrangements around denning sites.		
• 30% of habitats within 0.8 km (0.5 mi) should be foraging habitat.		

Table 1. Continued.

Description	Location of Study	Reference
DENNING HABITAT REFERENCES		
Stands that are at least 1 ha (2.5 acres) in size and northerly aspects.	NC Washington	Koehler and Brittell 1990
Stands greater than 200 year old Engelmann spruce-subalpine fir-lodgepole pine overstories having N-NE aspects; these sites also had a 1989, unpubl.; high-density (>1/m) of downed trees supported 0.3-1.2 m (1-4 ft) above the ground, which provided both vertical and horizontal structural diversity.	Washington	Brittel et al. Koehler 1990
Several denning sites per sub-drainage with travel cover in between them.		IdahoRoloff 1995*a*
Late-successional stands with down woody debris for thermal and security cover and denning.		Washington Koehler and Aubry 1994
Although disease and insect attacks may increase fuel loads and the risk of		Washington
Large, high-intensity fires, they also provide dead and downed trees used for denning cover.		Koehler and Aubry 1994
Recommendations for consideration in development of guidance for Colorado denning habitat (from Idaho Conservation Strategy, Roloff 1995) Stand scale • Vegetation classified as large-sized. • Greater than 50% canopy closure. • Northerly aspects. • Pockets of dense, vertically stratified, down woody debris. • Down woody debris greater than 1 piece/meter (3 ft). • Vertical stratification 0.3-1.2 m (1-4 ft above the ground). Sub-drainage scale • Minimum individual unit size-5 ha (12.5 acres). • At least 5 per sub-drainage. • 50% denning adjacent to travel or foraging habitats.		
TRAVEL HABITAT REFERENCES		
Coniferous or deciduous vegetation greater than 2 m (6.5 ft) in height with a closed canopy.	Washington	Koehler and Aubry 1994
Clearcuts greater than 100 m (328 ft) wide may create barriers to lynx movements.	Washington	Koehler and Aubry 1994
Recommendations for consideration in development of guidance for Colorado travel habitat (from Idaho Conservation Strategy, Roloff 1995)		

Table 1. Continued.

Description	Location of Study	Reference
Stand scale • Vegetation greater than 2 m (6.5 ft in height) with closed canopy (winter cover). • Created openings less than 91 m (300 ft) in width (summer or winter cover). • Forested stands providing cover less than 2 m (6 ft) tall and less than 91 m (300 ft) in width (summer cover). • Forested stands having greater than 72 trees/ha (178 trees/acre) and 2-3 m (6.5-10 ft) understory providing greater than 50% cover (winter cover). Sub-drainage scale • Provide travel habitat adjacent to denning and foraging habitats in patterns that facilitate connectivity.		
HOME RANGE REFERENCES		
12 km^2 (4.6 mi^2)	Alberta, Alaska	Brand et al. 1976
1,500 km^2 (540 mi^2)	Washington	Koehler 1990
243 km^2 (94 mi^2) for colonizing new and expanding population w/little overlap of males and females, suggesting a pattern of spacing more similar to that of mountain lions than bobcats.	Minnesota	Mech 1980
Variable w/some contradictions from data correlating prey density and home range size.	Alberta, Yukon	Brand et al. 1976, Ward and Krebs 1985
Habitat management for lynx would benefit from a consideration of local home range sizes and distributions, and vegetative and physiographic features that may serve as home range boundaries.	Washington	Koehler and Aubry 1994
Recommendations for consideration in development of guidance for Colorado home range (from Idaho Conservation Strategy, Roloff 1995) • No quantitative estimate at this time. • Vegetative and physiographic features of conifer, mixed conifer, and mixed conifer/deciduous will likely define Colorado home ranges.		
Recommendations for consideration in development of guidance for Colorado dispersal barriers (from: Idaho Conservation Strategy, Roloff, 1995) • Interstate highways (I-70, major state highways (to be identified), major waterways (to be identified), and large areas of non-lynx habitat.		
PRIMARY CONSERVATION AREA REFERENCES		
Primary Conservation Areas should be delineated in consultation with State and Federal agencies.	Idaho	Roloff 1995
Primary Conservation Areas should be delineated based upon potential and existing habitat and on historic lynx observations.	Idaho	Roloff 1995
Secondary Conservation Areas should be delineated based upon potential and existing habitat where no former historic lynx observations have occurred.	Idaho	Roloff 1995
Recommendations for consideration in development of guidance for Colorado primary conservation area (from Idaho Conservation Strategy, Roloff 1995)		

Table 1. Continued.

Description	Location of Study	Reference
Regional and Drainage Scales		
• In general, Primary Conservation Areas should be delineated as being one or more sub-drainage landscapes dominated by sub-alpine and upper montane coniferous forests. Permanent openings/ non-lynx habitats should be sub-dominant within the forested landscape.		
• Vegetative and physiographic features of conifer, mixed conifer, and mixed conifer/deciduous in combination with areas of low levels of human activity and development such as designated wilderness or non-motorized management, in combination with historic lynx observations, should be the areas of initial focus when delineating Primary Conservation Areas.		
• Management in primary conservation areas should emphasize the guidelines suggested for lynx foraging, denning, and travel indicated in this Strategy as the sub-drainage and stand levels.		
• Vegetative and physiographic features of conifer, mixed conifer, and mixed conifer/deciduous in combination with areas of low-human uses, should be the areas of initial focus when delineating Secondary Conservation Areas.		
HABITAT EFFECTIVENESS REFERENCES		
Minimize human access in Primary Conservation Areas.	Idaho	Roloff 1995
As (open) road density increases, road avoidance by wildlife results in less habitat being suitable.	US	Forman and Hersperger 1996
Mountain lion – 1.0 mile per square mile - maximum threshold for species to maintain a home range.	So. Utah	Van Dyke et al. 1986
Bear harvest – 1.0 mile per square mile - threshold that bear harvest decreased to 50% less per 100 mi^2 per year.	New York	Brocke et al 1990
Elk – 1.6 miles per square mile - threshold that 50% of area remained suitable elk habitat.	Rocky Mtns.	Rost and Bailey 1979 Lyon 1983
Wolf – 1.6 miles per square mile - threshold of no wolves in 2 areas contiguous to primary habitat.	No. Great Lakes	Thiel 1985, Jensen et al. 1986, Mech et al. 1988
Open road defined as a road without restriction of motor vehicle use.		
Restricted Road defined as a road on which motorized vehicle use is restricted seasonally or yearlong. The road requires physical obstruction (generally gated) and motorized vehicle use is legally restricted (except for acceptable administrative uses).		
Reclaimed or Obliterated Road is a road which has been treated in such a manner so as to no longer function as a road or trail.		
Open Motorized Trail is a trail without restriction on motorized use and is used by motorized vehicles.		
Restricted Motorized Trail is a trail on which motorized use is restricted seasonally or yearlong. Motorized use is legally restricted (except for acceptable administrative uses).	Montana	IGBC 1994

Table 1. Continued.

Description	Location of Study	Reference

Recommendations for consideration in development of guidance for Colorado habitat.

Summer and Winter, Open Road and Open Motorized Trail Density - Sub-drainage and Drainage Scales

- Open Road and Open Motorized Trail densities in Primary Conservation Area should range less than 1.0 mile per square mile.
- Open Road and Open Motorized Trail densities in Secondary Conservation Areas should range less than 2.0 miles per square mile.

Winter motorized vehicle access should be prioritized to utilize non-forested habitats or existing roads and trails except where a new road or trail is being relocated to minimize predicted adverse effects to lynx, wolverine or other wildlife.

Primary and Secondary Conservation Areas should not include areas of concentrated, non-motorized recreation and human activity (such as Vail Pass or Indian Peaks trail).

HABITAT PROTECTION / ENHANCEMENT REFERENCES

Thinning stands (lodgepole pine) early to maximize tree-growth potential can be compatible with snowshoe hare and lynx needs provided that stands are thinned before snowshoe hares recolonize The area. Both early and late thinning strategies may be required when integrating timber management objectives with lynx habitat needs.	NC Washington	Koehler and Aubry 1994
Approximating the natural disturbance frequency and spatial patterns present on the landscape is expected to provide the best habitat for lynx. Frequent, small-scale disturbance is expected to provide the best lynx habitats in the southern latitudes.	NC Washington	Koehler and Aubry 1994
Timber harvest, stand thinning, artificial regeneration, and prescribed fire are appropriate tools to achieve habitat objectives.	Nationwide	FSM 2670

Recommendations for consideration in development of guidance for Colorado habitat protection and enhancement

Stand, Sub-drainage, and Drainage scales

- Avoidance of and maintenance of habitat effectiveness are priority management approaches in conserving key lynx habitat features.
- By focusing
- Timber harvest, stand thinning, artificial regeneration, and prescribed fire are appropriate tools to achieve habitat objectives.
- Thinning stands to maximize understory vegetation or tree-growth potential can be compatible with snowshoe hare and lynx needs provided that stands are thinned before snowshoe hares recolonize the area. Both early and late thinning strategies may be required when integrating timber management objectives with lynx habitat.
- Approximating the natural disturbance frequency and spatial patterns present on the landscape is expected to provide the best guidance, locally, for lynx habitats. Several Forest Planning documents discuss natural or historic ranges of variation for the Arapaho-Roosevelt, Routt, White River, and Rio Grande National Forests.

Habitat Goals and Objectives

Very little is known about requirements or habitat preferences of lynx in Colorado. This necessitates that the conservation strategy utilize data from other study areas to predict the likely requirements needed by a reintroduced population. If these lynx are reintroduced, the intensive monitoring should provide more specific data needed to adjust the predictions and refine the preferred habitats for the species in the SRM. Until that time the conservation strategy will be based on the best information available. This must be a flexible strategy that will change as management agencies collect additional information on the species after release.

Objective 1: Identify potential habitat statewide.

Assumptions: Lynx habitat appears to be associated with snowshoe hare habitat. In the SRM snowshoe hares can be found in a variety of habitats and vegetation. Large blocks of connected habitat will be identified using GIS vegetation mapping. Layers in the GIS analysis of habitat will include spruce/fir (Engelmann spruce, subalpine fir, Douglas fir [*Pseudotsuga menzeisii*]), and perhaps blue spruce (*Picea glauca*), white fir (*Abies concolor*), lodgepole pine including some ponderosa pine (*Pinus ponderosa)*, limber pine (*Pinus flexilis)*, and bristlecone pine (*Pinus aristata*), aspen, Gambel's oak (*Quercus gambeli*), dense mountain shrubs, and high elevation riparian willow (*Salix* spp). This, in concert with vegetation zones known to be used by snowshoe hares, CDOW GIS maps of potential snowshoe hare range should provide a coarse filter of potential lynx habitat.

Methodology: Delineate potential habitat using GIS vegetation analysis based on the following criteria:

a. Potential lynx habitat based on vegetative structure (Table 1) and historic presence.
b. Connected mosaic of mixed conifers with a juxtaposition of denning, forage, and travel corridors connecting the components.
c. These areas will need to contain all components in blocks >1,500 km^2 (540 mi^2) (Koehler 1990).
d. Pre-release snowshoe hare surveys will validate forage density.
e. Post-release monitoring will further define potential habitat.
f. Focus on areas of low human use such as designated wilderness and semi-primitive, non-motorized management areas.

Objective 2: Identify linkage zones connecting potential habitats statewide and maintain those potential linkage zones for dispersing lynx.

Assumptions: In order for introduced populations of lynx to use the potential habitat available in the state, linkage zones between the habitats must exist. Movements and dispersions are probably most impacted by human-induced barriers and large natural open areas. Individual lynx avoid open areas in the Northern Rockies and Cascades (Koehler 1990).

Methodology: Identify and map linkage zones and delineate potential barriers to movement or residency. Intensive post-release monitoring of lynx populations may refine identification of barriers and linkage zones associated with population expansions. Protection of potential

linkage zones and mitigation of barriers will help ensure the widest use of potential habitat. Attempt to mitigate factors that may change a semipermeable barrier to a temporal barrier or remove the barrier altogether. Protection of linkage zones is most important during male dispersal periods (late winter, early spring).

Objective 3: Select suitable reintroduction areas and release sites to ensure the best chance of a successful recovery. Selected areas should have linkage to other suitable areas to ensure that an expanding population will be able to colonize new areas. Social and economic considerations to maximize survival of lynx as well as minimize impacts to people living in surrounding areas should be considered by agencies.

Assumption: The largest areas of contiguous or linked habitat meeting the requirements of objectives 1, 2, and 3 would be the best areas for a possible reestablishment. Snowshoe hare populations could be the limiting factor to a successful establishment of this population (Slough and Mowat 1996*b*). To refine the sites chosen through the GIS analysis, a relative abundance of snowshoe hare will be necessary to select suitable reintroduction areas.

Methodology:

1. Using GIS mapping, identify the best potential habitats (Table 1).
2. Conduct statewide snowshoe hare track survey in winter of 1997-98 in all potential habitats, collect data on distribution and relative abundance of snowshoe hare and related prey species, potential predators/competitors and document all lynx tracks (Appendix H).
3. Conduct Krebs Snowshoe Hare Pellet Survey in August to October 1998 of 4-6 best areas as indicated by track survey, and other areas not covered by track survey (Appendix I) .
4. Review data from snowshoe hare surveys and in consultation with LAT and select reintroduction areas.

Objective 4: Refine habitat criteria during post-release monitoring.

Assumptions: Intensively monitoring radio-collared lynx will provide information on habitat preference including denning sites, kitten rearing habitat, forage areas, travel corridors, and barriers.

Methodology:

1. Locate each lynx and record its location in Universal Transverse Mercator (UTM) coordinates 3 times a week for the first 60 days after release and then 2 times weekly until the transmitter fails or a mortality is recorded. Data collected will include date, time, UTM coordinates, habitat type, slope, aspect, and comments.
2. Analyze location data to make inferences on preferred habitats, home ranges, forage areas, denning areas, kitten rearing areas, and travel corridors.

Objective 5: Refine habitat protection recommendations based on information collected from released lynx.

Assumptions: Post-release monitoring will provide information on habitat preferences specific to Colorado and can be used to refine habitat protection recommendations.

Methodology:

1. Analyze habitat preference data gathered post-release to determine if conflicts exist that would jeopardize the recovery of lynx in Colorado.
2. As habitat information is refined, modify the Conservation strategy as necessary. As conflicts are identified, develop conservation strategies and land management regulations to mitigate the them.

Conservation Actions

Species Reestablishment

Assumption: To reestablish and maintain a long-term metapopulation of lynx in the SRM we have to transplant lynx into suitable habitats and monitor.

Methodology:

1. Identify suitable habitat areas for release sites as discussed in Habitat Objectives.
   a. Determine potential carrying capacity for reintroduction areas. Using mean overlapping home ranges of __ km^2 (___ mi^2) (to be determined by LAT) to calculate the number of animals to be released into the selected areas (Quinn and Parker 1987).
   b. Prioritize release sites using overall size of the suitable habitats, potential denning sites, travel corridors, and snowshoe hare densities.
   c. Choose at least 2 reintroduction areas and associated release sites yearly in or adjacent to the best areas. The number of reintroduction areas will be determined by the number of lynx captured for transplant and the carrying capacity of the areas. The initial plan calls for 100 lynx per year for 2 years.
2. Acquire live-trapped lynx from private trappers in Canada or Alaska. The CDOW has received positive replies from Alaska, Yukon, British Columbia, and Alberta (Appendix J).
3. Use LAT to evaluate and recommend release procedures.
4. Prior to release, have each animal inspected by a veterinarian, attach radio transmitters and take blood and hair samples for DNA analysis from each lynx.
5. Intensively monitor lynx post-release. Each lynx will have a radio transmitter collar which will identify the individual. Any mortalities will be investigated in an attempt to determine the cause of death. In addition to determining habitat preferences, home ranges and reproductive status will be studied.

Evaluation

The data collected by research over the 2-year period of 1998-2000 will be analyzed. Research will be conducted to evaluate habitat use, dispersal and survival. These data will be used to further the knowledge about habitat requirements and preferences for this species.

Mapping of Potential/Suitable Habitat

The habitat preferences will be identified and mapped in GIS computer program. This information will be used to select habitat blocks that will be verified and validated to reflect the data collected through radio telemetry. These criteria will be used to identify other blocks of potential habitat located throughout the SRM.

Habitat Needs/Enhancement

Mapped habitat blocks will be identified as potential key lynx habitat. These areas should be site-specifically validated. As new habitat needs information is identified, recommendations should be made to adjust this conservation strategy.

Approximating the natural disturbance frequency and spatial patterns present on the landscape is expected to provide the best habitat for lynx. Frequent, small-scale disturbance is expected to provide the best lynx habitats in the southern latitudes (Koehler and Aubry 1994). Several National Forests in Colorado have developed Range of Variation documents (Arapaho-Roosevelt, White River, Routt, and Rio Grande) which discuss local ecological patterns. Timber harvest, stand thinning, artificial regeneration, grazing management, and prescribed fire are some examples of appropriate tools that may achieve habitat objectives.

The effect of occurrence of humans in lynx habitats is largely undocumented and not well understood.

Research

There are more questions about lynx survival in the SRM than there are answers. Extensive research on snowshoe hare ecology is badly needed. During the course of this reintroduction those issues or questions that are identified as critical to the recovery will be evaluated for future investigations. The most important questions should receive preference for research funding.

INFORMATION AND EDUCATION

Public support for the reestablishment of lynx is essential to its success. Public support is contingent upon 4 ingredients: 1) widespread public awareness and understanding of conservation goals, objectives, and strategies; 2) evidence of careful assessment of biological, economic, and political risks; 3) evidence of significant public support and/or approval for the lynx conservation strategies and expected outcomes; and 4) justification for an affirmative reestablishment decision.

Widespread public awareness and understanding of the conservation strategy will be achieved in 3 ways. A draft of the conservation strategy will be released to the public via a "meet the public forum" which will include members of the press and interested members of the public. Copies of the conservation strategy will be mailed to all organizations currently listed in the mailing lists of

the cooperating agencies (Colorado Division of Wildlife, U.S. Forest Service, U.S. Fish and Wildlife Service, and the National Park Service). Additional copies will be available upon request. Public meetings will be scheduled to review the contents of the conservation strategy with those in attendance and to respond to questions and suggestions for revision. Lastly, the cooperating agencies will issue periodic news releases summarizing the contents of the conservation strategy and progress towards its implementation.

Evidence of the biological, economic, and political credibility of the conservation strategy will come from rigorous peer review of the document by recognized authorities who have no affiliation with the recovery program. In addition, extensive public review will provide additional opportunities for technical reviews of the proposed conservation strategy.

Evidence of significant public support will follow from the implementation of an incremental phase public involvement model (Fig. 3). The incremental phase model is designed to include public input only to the extent necessary to demonstrate and/or secure significant public support for a proposed management or policy decision. Phase one aims at raising public awareness and understanding of a proposed public policy or management action. It is achieved through extensive and inclusive public information campaigns and evaluated by direct public responses or comments during public meetings and written comments received from reviews of drafts of the conservation strategy. If no significant public opposition to the proposal results from phase one activities, widespread public support (or at least minimal opposition) to the proposal is assumed and no further public involvement is required. If, however, significant public opposition or concern results during phase one, public involvement is incremented to phase two.

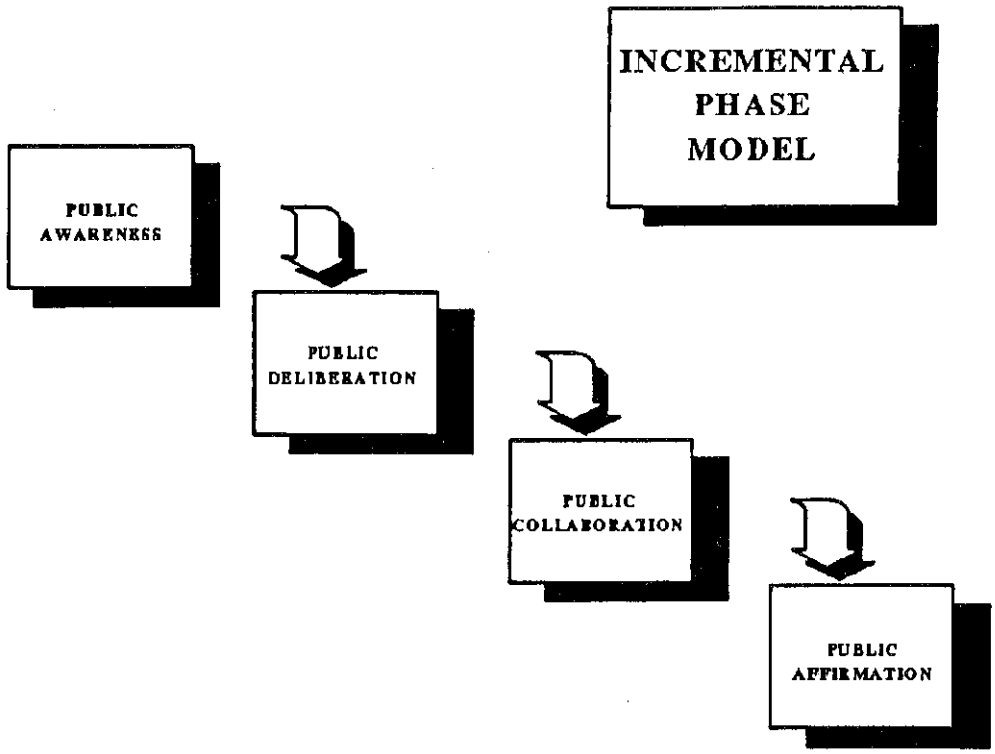


Fig. 3. Incremental phase model for effective public involvement in management decisions.

Phase two aims to engage the public in significant deliberation over contested issues and/or alternatives that result from phase one. In the case of the lynx conservation strategy, public deliberation will be implemented via an interactive public survey instrument which not only asks the respondents to reply to specific questions, but which also engages them in interactive dialogue with the interviewer to develop resolutions to outstanding questions, issues, and conflicts (Kathlene and Martin 1991; Fishkin 1993, 1995). Upon completion of the deliberative public survey, the conservation strategy will be revised and redistributed to interest groups and the public-at-large for further comment. If no significant public opposition results from the revised proposal, public support for the revised conservation strategy will be assumed and active solicitation of public involvement will terminate. If significant public opposition prevails even after phase two, public involvement will increment to phase three.

Phase three is a public collaboration phase which calls for the formation of a stakeholder process to engage stakeholders in substantive discussions and debates to resolve outstanding issues and conflicts. Stakeholders will include representatives from interest groups, agencies, and the public-at-large and would be charged with developing consensus alternatives to resolve outstanding issues with the draft conservation strategy (examples of comparable deliberative processes can be found in Maguire and Boiney 1994, Curtis and Hauber 1997, Guynn and Landry 1997, Merkhofer et al. 1997, Moote et al. 1997, Steelman and Ascher 1997). In the event that the stakeholders can not reach consensus on ways to resolve outstanding issues, public involvement will increment to phase four.

Phase four is a decision phase which is specifically designed to yield public decisions over issues where stakeholder deliberations become stalemated. Brown et al. (1995) refer to this process as a *values jury* approach to public decision-making. A values jury consists of 20-40 randomly selected adult citizens who hear competing arguments and evidence concerning conflicting policy or management alternatives. The jury then decides which of the competing alternatives to implement analogous to the way a judicial jury decides contested issues of law. Decisions made by the values jury concerning conflicts with the content of the draft conservation strategy would be ratified and/or modified by the agency decision makers and incorporated into the final conservation strategy.

LAW ENFORCEMENT

The Current Status:

Colorado Revised Statue 33-2-105 provides for the Wildlife Commission to establish a list of those species or subspecies of wildlife indigenous to this state that are determined to be endangered or threatened with this state.

Wildlife Commission Regulation, Chapter 10, Nongame Wildlife, Article II Endangered Wildlife, #1002 Designation of Species further provides the listing of species determined to be endangered in Colorado. This list includes lynx.

Colorado Revised Statue 33-6-110(a), sets the fine for take or possession of lynx in Colorado at $1,000.00.

No additional measures are proposed at this time.

ACTION PLAN

Activity	Parties Responsible	Proposed Date	Cost
Prepare Draft Cons. Strategy	Lynx Conservation Team	December 1, 1997	$1,600 CDOW $???? USFS*
Begin public involvement Future NEPA to implement CS	Lynx Conservation Team USFS	December 1997 Future	$200 CDOW $????
Conduct habitat assessment	USFS, CDOW, NPS	Dec 1997-Mar 1998	
Conduct GIS analysis of veg.	USFS, CDOW	Dec 1997-Mar 1998	$????
Conduct snowshoe hare track survey on SRM	CDOW, USFS, NPS volunteers	Dec 1997-Apr 1998	$2,000 CDOW $???? NPS (1998)**
Conduct Krebs pellet transect	CDOW Research	Aug-Oct 1998	$25,000 CDOW $???? NPS (1998)
Select 2 release sites	CDOW, LAT	Nov-Dec 1998	$1,500 CDOW
Obtain/release lynx	CDOW	Winter 1998 to 2001	$196,900 not funded
Begin monitoring First year	CDOW	Upon release	$603,000 not funded $150,000 CDOW
Refine habitat criteria	USFS, CDOW	Post 1st yr monitoring	$4,000 CDOW
Identify potential habitat	USFS, CDOW	Post-monitoring	$????

* USFS fiscal support is undetermined at this time.
**NPS has budgeted $74,000 over 3 years to support CS.

LYNX FUNDING

A draft budget has been prepared and is included in Appendix B. This budget indicates that over a 3-year period to accomplish the objectives outlined in this proposal funds estimated at $1.586 million for lynx reestablishment would be required. It is proposed that $1.134 million will need to come from private sources.

SOCIAL AND ECONOMIC ISSUES

All the social and economic issues have not been identified at this time. These issues will be addressed through each agency's unique planning processes as they implement the recommendations of the strategy. With the release of this document the identification of those issues will begin. The first one will be, should we reintroduce this species to Colorado and at what cost?

REVISION OF CONSERVATION STRATEGY BASED ON NEW INFORMATION

The Conservation Strategy will be revised as new information becomes available from this reintroduction and from other studies being conducted on this species and its ecology. This Strategy will be updated as needed by the Lynx and Wolverine Conservation Team.

CHAPTER 2. WOLVERINE

CONSERVATION STRATEGY FOR THE WOLVERINE

Interagency Memorandum of Agreement

On July 8, 1997, representatives of the U.S. Forest Service, U.S. Fish and Wildlife Service and the Colorado Division of Wildlife met to discuss a cooperative program for the conservation and reestablishment of lynx and wolverine in Colorado. On August 4, 1997, those agencies plus the U.S. National Park Service (Rocky Mtn.) signed a letter agreeing to jointly prepare "A Candidate Conservation Strategy for Lynx and Wolverine in Colorado" (Appendix D).

History and Distribution

The status of wolverine (*Gulo gulo*) in Colorado is undetermined. Nead et al. (1985) reported that wolverine are native to the state but appear to be scarce. They were able to find 22 records representing 25 animals documented in the literature that were collected between 1871 and 1919. Since that time, 3 more specimens have been reported in or near Colorado. A skull was found in July 1977 in the Cimarron Creek drainage (Gunnison County) that was estimated to be between 10 and 100 years old (Steve Bissell, pers. commun.). Also, 2 specimens have been collected near the Colorado border. One specimen, an adult male, was shot in Utah just west of Dinosaur, Colorado in March 1979 and another adult male was trapped 18 miles north of Cheyenne, Wyoming in April 1996. The biological record is confounded by the escape from the Cheyenne Mountain Zoo of 6 wolverines from 1964 to 1986. Three of these wolverine were probably recaptured along the front range (Byrne 1997). Also, a male and a female wolverine were released into the Castle Creek area near Aspen in 1979 by private individuals (Jim Halfpenny, pers. commun.). The CDOW maintains a data base of wolverine records and observations (Byrne 1997). Presently there are 33 "A" or positive records, 53 "B" or probable observations, and 410 "C" or possible observations. Ten of the "A" records are from the 6 escaped wolverine from the Cheyenne Mountain Zoo (6 records), the recovery of 3 of these wolverine (3 records), and the release of the 2 wolverines near Aspen (1 record). Other than the recent wolverine specimens dicussed above, there are not any known specimens of Colorado wolverine available for inspection.

Recent Investigations

Since 1979, 12 investigations have been conducted in Colorado with the goal of trying to document presence of lynx or wolverine (Appendix F). No investigations have been conducted in those portions of the former wolverine range located in northern New Mexico (Schmitt pers. commun.), or in Wyoming (Oakleaf pers. commun.). After intensive efforts using snowtracking (5,833.5 miles), hair snags (62 locations), remote cameras (110 locations) and snares (686 trap nights) only 10 sets of tracks that *appeared to have a high probability* of being wolverine were found. The CDOW has offered a $500 reward for any positive information on wolverine since 1993 and has not received any. There have not been any road kills or accidental trapping or shooting of wolverines reported. The CDOW has concluded that *if* any wolverine remain in Colorado their numbers are so small that they do not represent a viable population and are not detectable by known census methods. It is quite possible that wolverine have been extirpated from Colorado (Byrne 1997 pers. commun.).

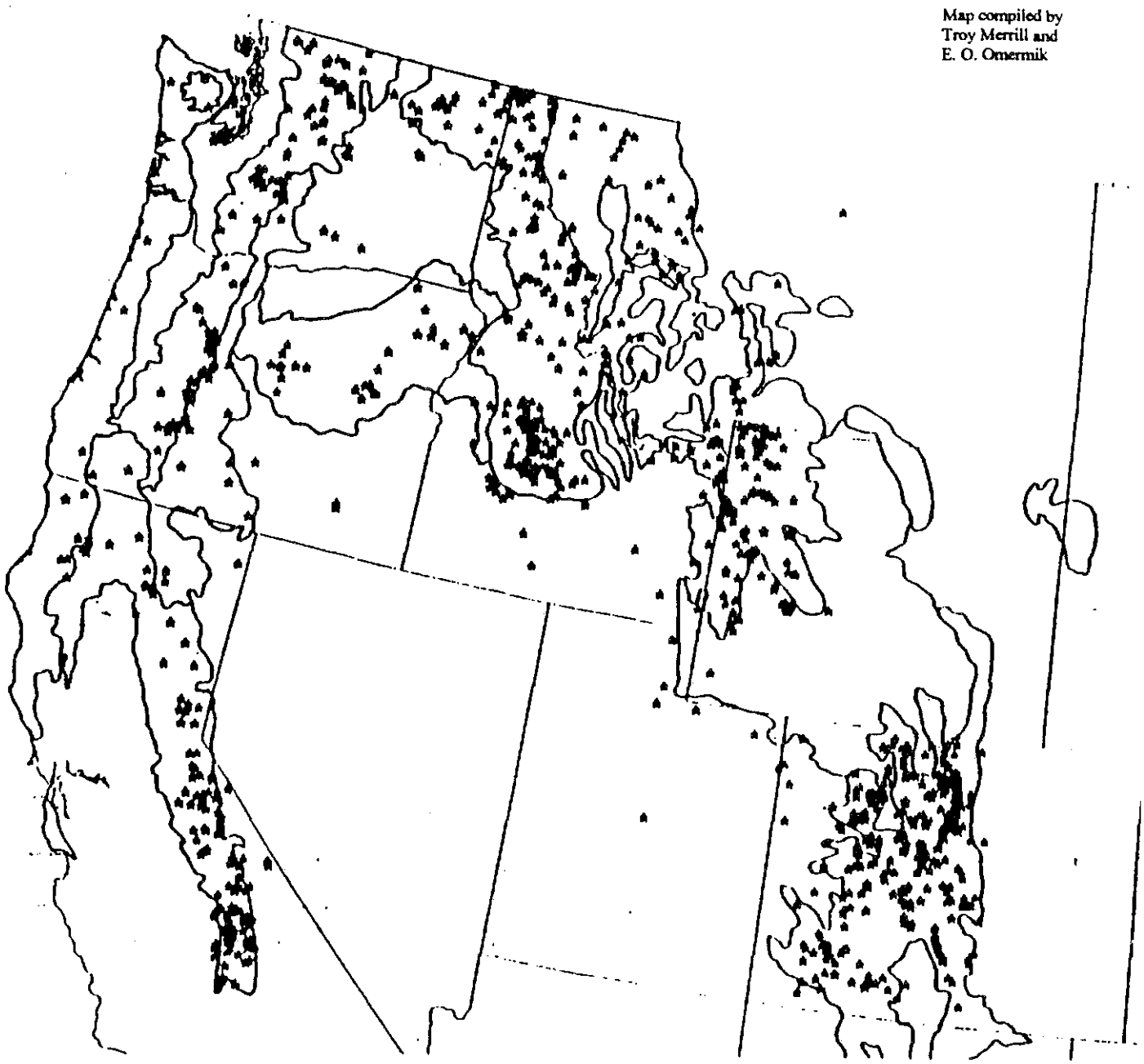


Figure 4. Historical distribution of wolverine in the western United States.

Current Management Status in Colorado

- The season on wolverine was closed by the Colorado Wildlife Commission (CWC) on March 25, 1971.
- Wolverine were designated a *state* endangered species in January 1976 by the CWC. This protects the species from being killed or possessed, but does not protect the habitat.

- The U.S. Forest Service designated wolverine as a sensitive species in 1993. This means the species and its habitat are given special consideration during management planning efforts.
- The USFWS was petitioned to list the wolverine as threatened or endangered throughout its contiguous U.S. range, but the result of a 90-day finding was that the petition contained insufficient information to list (Federal Register 1995).
- Amendment 14 approved by the voters of Colorado in the November 1996 greatly restricted the use of poisons, leghold, kill-type and snare trapping devices in the State of Colorado.

Taxonomy

The taxonomic arrangement accepted here regards Old and New World wolverines as conspecific rather than as 2 species (Fitzgerald et al. 1994).

Species Ecology

Wolverines are blocky mustelids. The color is medium brown to dark brown, with a broad yellow-brown lateral stripe that extends from the neck to the rump. There is often a pale facial mask. The tail is bushy, about one-fourth of the length of the body. The feet are large with five toes and during the winter thick hairs develop on the soles. Males average 10% longer and 30% heavier than females (Fitzgerald et al. 1994).

The wolverine is primarily an animal of boreal forests and tundra. Wilson (1982) indicated they preferred marshy areas. Large populations of ungulates were reported to be important components of wolverine habitat (van Zyll de Jong 1975, Hornocker and Hash 1981). The wolverine has one of the lowest densities of any North American carnivore (van Zyll de Jong 1975). Wolverine are nocturnal and active year round. They usually pair only to mate, although Hash (1987) and Copeland and Hudak (1995) reported adults together in winter. Young travel with the female and disperse in the late summer and fall. Wolverines mark food caches, and perhaps territories, using scent or scarring trees (Koehler et al. 1980, Hornocker and Hash 1981).

Home Ranges

Hornocker and Hash (1981) reported home ranges overlapped in Montana with no evidence of territoriality; European studies suggest intra-sexual territories are established. Home range varies from 94-388 km^2 (35-142 mi^2) for females, and 422-666 km^2 (155-245 mi^2) for males, in Alaska and Montana. Lactating females have the smallest home ranges (Hash 1987). Larger home ranges relate to movements of ungulates or activity when breeding. Individuals may move more than 30 km (18 mi) in 1 night (Wilson 1982). Movements of juvenile transients may exaggerate size of reported "home ranges."

Diet

Wolverines eat small rodents, rabbits, porcupines, ground squirrels, marmots, bird eggs, birds, fish carrion, roots and berries. Most ungulate remains in their diet are probably carrion (Hash 1987, Wilson 1972). Hornocker and Hash (1981) reported they fed on mountain lion kills. The winter diet is mostly carrion or mammal prey; diet is more diverse in other seasons. Wolverines cache surplus food. They communicate with scent markings and urine and abdominal rubbing (Copeland and Hudak 1995*a*).

Reproduction

Wolverines breed from spring to early fall in Alaska and the Yukon (Rausch and Pearson 1972, Magoun and Valkenburg 1983). Blastocysts implant January-February. Mead (1991) and Mehrer (1976) estimated gestation at 215-272 days. Rausch and Pearson (1972) estimated active gestation at 30-40 days post-implantation. Young are born in March or April. Litter size varies from 2 to 5 (average 2 to 3). Montana litters are smaller than those of more northern areas (Hornocker and Hash 1981). Young are born in dens in log jams, under rocks, or under tree roots (Hash 1987). Reproductive success is low due to kit loss, lack of mating opportunity, and breeding age (Hash 1987). Females are reproductively mature as 2-year-olds, but may not reproduce (Liskop et al. 1981). Animals rarely live past 10-11 with 4-6 years the average for Montana (Hash 1987).

Mortality Factors

Other than humans and wolves, predators are few. There are no published reports of any chronic diseases or parasite disorders that might have implications for wolverine populations. (Hatler 1989). Both wolves and mountain lions have killed wolverine (Copeland and Harris 1994). The wolverine is susceptible to poison baits and may have suffered population declines during the use of strychnine that was developed during the late 1880s. The use of 1080 (sodium monofluoro-acetate) baits that had widespread use in Colorado prior to 1972 (Dagg and Campbell 1974, from Hatler 1988) could have further reduced remaining populations .

SUMMARY OF FACTORS AFFECTING THE SPECIES

Throughout its North American range, the wolverine occupies a wide variety of habitats although its distribution appears to center on areas with little human use such as back country, wilderness, roadless or trailless areas. Wolverine population densities rarely exceed 1 animal/100 km^2 (Copeland and Hudak 1995*a*). In Colorado, potential wolverine habitat is naturally fragmented and subject to intense winter and summer recreation (Byrne pers. commun. 1997).

The following components appear central for the management of wolverine: 1) wolverines need adequate space for population maintenance; 2) geographically isolated populations must be avoided to maintain genetic, social, and spatial continuity of sub-populations; 3) the environment must be capable of providing a varied seasonal diet; 4) security areas must be available to provide undisturbed seclusion for reproducing females (Copeland and Hudak 1995*a*).

1. The present or threatened destruction, modification, or curtailment of the species' habitat or range.

Wolverine presence appears to be tied to areas of low human disturbance. Refugia may support remnant populations although their extent and structure are not well understood. Refugia provides core habitat for wolverine populations; however, increased human presence or reduction or alteration of existing refugia may threaten wolverine persistence (Copeland and Hudak 1995*a*). Human occupation and habitat alteration of potential dispersal corridors (cover/travel habitat) may isolate subpopulations, increasing their susceptibility to extinction processes.

Home ranges in Idaho varied from 80 to over 700 km^2 for females and over 2,000 km^2 for resident males (Copeland and Harris 1994). Large spatial requirements may be necessary to the foraging, denning, and kit rearing characteristics of the wolverine.

Occurrence of wolverine in various forest cover types is most likely associated with food availability (Gardner 1985, Banci 1987) and the selection of den sites for reproduction. Wolverine use of high alpine areas was attributed to the presence of arctic ground squirrels in south-central Alaska and higher availability of ungulate carrion in southwestern Yukon (Banci 1987). Female wolverine in Idaho use subalpine cirque habitats for natal denning and kit rearing while making daily forays into lower montane habitats to forage (Copeland and Harris 1994). The movement of Montana wolverines out of high elevation sites during winter months may have been in response to lower human densities as well as availability of ungulate carrion at lower elevations (Hornocker and Hash 1981).

Banci (1994) described the best habitat for wolverine in the Yukon as boreal forest characterized by mountains and plateaus separated by wide valleys and lowlands, with extensive subalpine and alpine habitats. In Idaho, montane coniferous forests suitable for winter foraging and summer kit rearing may only be useful if associated with subalpine cirque habitats required for natal denning, security areas, and summer foraging. In addition, these habitats must be available during the proper season. Subalpine cirque areas potentially useful for natal denning may be made unavailable by winter recreational activities. Conversely, high road densities, timber sales, or housing developments pushed to the fringes of subalpine habitats offer little for winter foraging or kit rearing and increase the probability of human-related wolverine mortality (Copeland and Hudak 1995*a*). Female wolverines in Idaho preferred secluded subalpine talus sites for natal and kit rearing dens (Copeland and Harris 1994). Post-weaning rendezvous sites for kits and adult females included large boulder talus and mature spruce/fir riparian sites with dense understory and forest floor debris. Boulder talus was also associated with foraging during both winter and summer months and may be important as thermal cover. Mining activity, road building, or developed campgrounds near subalpine boulder talus sites may eliminate historical or potential wolverine foraging or denning habitat (Copeland and Hudak 1995*a*).

2. Overutilization for commercial, recreational, scientific, or education purposes.

In Colorado the wolverine trapping season has been closed since 1971. Although present distribution is confined to a few western states, Dagg and Campbell (1974, from Hatler 1988) believed wolverines may have historically resided in 22 of the 48 contiguous states. Additionally, they suggested over-trapping and hunting, habitat changes, intolerance to human developments, poisoning during predator control operations, and reproductive failure due to imbalanced sex ratios and/or reduced numbers as probable causes for the decline of the species. However, the reduction of poisoning programs and current protection status afforded the wolverine in the west may have allowed population increases and range expansion although this is not substantiated by recent data (Copeland and Hudak 1995*a*).

3. Disease and predation.

No published records exist of any chronic diseases or parasite disorders that might have implications for wolverine populations (Hatler 1988). Predation most likely has little regulatory effect on wolverine populations (Copeland and Hudak 1995*a*). The extirpation of the wolf from the SRM removed a potential predator from the reintroduction area.

4. Inadequacy of existing regulatory mechanisms.

The wolverine was classified as endangered by the State of Colorado in 1976 and trapping of it has been banned in Colorado since 1971 (J. Sheppard, pers. commun. 1997). The U.S. Forest Service classifies wolverine as a sensitive species in the Rocky Mountain Region. This designation serves as an early alert to develop and implement conservation strategies and insure that Forest Service activities do not cause these species to move toward federal listing. The U.S. Fish and Wildlife Service was petitioned to list the wolverine as threatened or endangered throughout contiguous U.S. range but the result of a 90-day finding was that the petition did not present substantial information indicating listing to be warranted (Federal Register 1995).

5. Other natural or manmade factors affecting the species' continued existence.

Colorado's forest landscapes have changed in the almost 20 years since the last wolverine was seen. Human population growth and associated expansion of recreational centers in the mountains has contributed to the creation of migration barriers, fragmentation of habitat, and a reduction in areas of solitude and refugia. Ungulate carrion is a primary winter food item and activities that decrease large mammal populations may negatively affect wolverine (Banci 1994). Colorado's ungulate biomass has increased since 1974 (Byrne pers. commun.). Reduction of ungulate populations by excessive harvesting and human-caused losses of wintering areas as well as displacement of ungulate populations due to timber harvest and urbanization may adversely impact wolverines in Idaho (Copeland and Hudak 1995*a*). Management practices that reduce the presence and opportunity for carrion availability may threaten wolverine foraging success (Copeland and Hudak 1995*a*). The extirpation of the wolf from the SRM has also removed a potential predator of and a carrion producer for the wolverine from the reintroduction area.

While in utero reproductive studies report high rates of pregnancy, studies on free ranging wolverine suggest a substantially lower incidence of successful reproduction. The incidence of a low reproductive rate in wolverines may be related to nutritional stress prior to parturition (Banci 1994). Factors that influence postpartum kit survival are not well understood. Human activity around wolverine dens in Norway resulted in den abandonment (Pulliainen 1968). Postpartum female wolverine appear to be extremely sensitive to disturbance during the pre-weaning kit rearing period. Recreational activities such as back-country skiing or snowmobiling may displace wolverines from potential denning habitat or cause den abandonment (Copeland and Hudak 1995*a*).

As a carnivore, the wolverine resides at a high trophic level and as such at low densities (Weaver 1993). Reported densities vary from lows of 1/500 km^2 in Scandinavia (Krott 1960) to a high of 1/65 km^2 in Montana (Hornocker and Hash 1981). Low density species may be more vulnerable to extinction processes and habitat loss. Over-exploitation may further fragment subpopulations and reduce distribution. As these subpopulations become smaller and more isolated they become increasingly susceptible to random or stochastic extinction forces including, demographic, environmental, and catastrophic events (Shaffer 1987, from Weaver 1993).

The wolverine is found in a wide variety of habitats. It can persist in the treeless tundra of arctic Alaska as well as the boreal forests of central Idaho as long as adequate space provides a buffer from human contact (Copeland and Hudak 1995*a*). Hatler (1989) commented that no particular habitat components can presently be singled out specifically for wolverines, and added that reduction of "refugia" through access and excessive and indiscriminate alteration for timber and

mineral extraction may be the greatest threat to local population viability. The wolverine has persisted in southwestern Alberta despite extirpation elsewhere in the province, largely because of the presence of large refugia in the form of national parks (Banci 1994). Since 1975, National Forest in the Rocky Mountain region have identified 60% of the region as forested land. Approximately 4.2 million acres are Engelmann spruce and subalpine fir. Additonally there are 2.8 million acres of lodgepole pine, 1.3 million acres of Douglas fir, 2.1 million acres of ponderosa pine, and 2.1 million acres of aspen (Rocky Mountain Region, Regional Guide). The majority of these forests are older forests in excess of 100 years of age.

WOLVERINE CONSERVATION STRATEGY FOR COLORADO

Introduction of wolverines from populations in Canada and/or Alaska has the best chance of restoring a viable population of wolverines to the state and removing them from Colorado's endangered species list. To ensure the best chance of a successful reestablishment, the potential habitat for wolverine will be delineated using the available knowledge acquired from studies in the western United States and Canada (Fig. 4). Once the best habitats have been identified, release sites will be chosen. The WAT will recommend release protocols for the animals to be released. Intensive monitoring of the released animals will provide information on preferred habitat, denning areas, foraging areas and corridors.

Species Goals and Objectives

Overall Goal: To reestablish the wolverine to a population which is viable in the SRM.

1. To reintroduce wolverine into suitable areas in order to establish a metapopulation in Colorado.

Objectives:

1. Select 2 suitable habitats for reintroduction
2. Obtain required number of Wolverine from northern locations.
3. Release wolverine into selected habitats.
4. Monitor released wolverine to determine home range establishment and reproduction.

Secondary Goal

2. To downlist the state listing of wolverine.

Objective:

1. A self-sustaining viable population of ___ animals that is stable or increasing is needed in order to downlist.

In the face of so many unknowns, transplanting wolverine is challanging but necessary to ensure a viable population of wolverine in Colorado. Information about the wolverine specific to Colorado is very limited. CDOW intends to call upon the LAT utilized in the lynx reintroduction, plus additional wolverine experts (WAT), for peer review and to provide recommendations on the numerous options involved in any future reintroductions. Post-release monitoring should provide the information needed on habitat preference, denning sites, linkage zones, density, and reproduc-

tion of wolverines in Colorado. Because assumptions made before release could be in error, flexibility of objectives needs to be understood.

A pragmatic goal for Colorado would be a population of ___ wolverines to ensure viability. This must be a flexible goal since the detailed mapping of suitable habitat has not been done. Once habitat is better delineated, a potential population can be predicted. Post-release monitoring of wolverine will further refine our knowledge of habitat capabilities.

Wolverine Habitat Requirements

Very little is known about requirements or habitat preferences of wolverine in Colorado. The only information that can be elucidated from the specimens in the state is a general location of where the species occurred. This requires that we use knowledge from other areas with wolverine to predict the likely requirements needed by an introduced population. Three models have been drafted for wolverine habitat in the northern Rockies. The authors concluded "Until we know more about wolverine biology, ecology, and habitat use, it is impossible to determine – let alone map – important habitat features with a high degree of confidence" (Hart et al. 1997). Once these wolverines are introduced, the intensive monitoring should provide more specific data needed to create the models and delineate the preferred habitats for the species in the state. Until that time we will base our recovery strategy on the best information available. This must be a flexible strategy which will change as we collect additional information on the species after release. Much of the information used and the format of the following section came from "Conservation Strategy for Wolverine in Idaho" (Copeland and Hudak 1995*b*).

1. Wolverines need isolation from the presence and influence of humans. This appears to be the most important element of wolverine habitat. The need for refugia is more important than vegetative type. Wolverines throughout their range are associated with large expanses of relatively undisturbed landscape. In Colorado, National Forest System lands are likely potential habitats for wolverine. Most areas are montane, subalpine, and alpine ecosystems of various proportions of forested and non-forested habitats. These existing areas of National Forest could serve as exisiting "secure" or "core" areas for wolverine. The most suitable areas would likely be identified throughout the Conservation Strategy development process.

2. Wolverines need adequate space to maintain populations. The larger the area of suitable habitat the better. Adequate space for a breeding subpopulation would include the home range of 1 male overlapping the home range of from 2 to 6 females. This would be an area of between 500 and 2,500 km^2 (193 and 965 mi^2). The more contiguous subpopulation home ranges there are in an area, the more preferable that area would be. We should select areas large enough to support up to 40 adult wolverine to reestablish a population.

3. Wolverines need secluded natal denning habitat. Females select den sites in the most secluded portion of their home ranges. Human activity around den sites has lead to den abandonment. The den sites are generally associated with talus slopes with large boulder (greater than 1m (3ft) in diameter) talus and fallen trees providing cavities for natal and nursery dens. Den sites are generally in glacial cirque basins with an aspect that ensures snow longevity and maintains den integrity into late winter.

4. Wolverines need isolated kit rearing habitat in their home range. This habitat is much like denning sites with the addition of a climax coniferous riparian forest. These are riparian zones

associated with old growth forest communities with Engelmann spruce a common component. A dense understory and downed trees provide security and function as rendezvous sites for mothers and kits.

5. Wolverines depend on a thriving ungulate population. Ungulate carrion is a primary winter food item. Hunter activities, e.g., field processing of game, wounding loss, or winter kills can play an important role in the availability of carrion. In other seasons the environment must be capable of providing a varied seasonal diet.

6. Wolverines use a variety of vegetation zones. Generally they are restricted to boreal forest and subarctic tundra. The boreal forests are characterized by extensive landscapes with a component of structurally complex, mesic coniferous stands that are characteristic of late stages of forest development (Banci 1994). It is generally agreed that wolverine habitat is best defined in terms of adequate food supplies in large, sparsely inhabited wilderness areas rather than in terms of particular types of topography or plant associations (Banci 1994).

Habitat Goals and Objectives

Objective 1: Identify potential habitat statewide.

Assumptions: Wolverine habitat appears to be associated with a component of seclusion or separation from human influence (Copeland and Hudak 1995*b*). Habitat of this kind can be defined as refugia and may be found in some National Parks, designated wilderness, or roadless areas. This, in concert with vegetation zones known to be used by wolverine and historical sightings, should provide for a coarse filter of potential wolverine habitat. Habitats can be classified as potential core or maintenance habitats (see Glossary).

Methodology: Delineate potential habitat based on the following criteria:

a. Potential wolverine habitat based on vegetative structure and historical presence.

b. Roadless areas including National Parks, designated wilderness areas, USFS and BLM designated, or other undeveloped, roadless areas.

c. Denning areas available and undisturbed (by snowmobiles or off-highway vehicles).

d. Kit rearing areas available (to be described).

e. Potential reintroduction areas need to provide an adequate prey and carrion base to support a population.

f. Minimum area to support a reasonable density over a large area.

g. Post-release monitoring will further define core and maintenance habitat.

Objective 2: Identify linkage zones connecting potential wolverine habitats statewide and maintain those potential linkage zones for dispersing wolverines (nonbarriers to movement).

Assumptions: In order for introduced populations of wolverine to use the potential habitat available in the state, linkage zones between the habitats must be viable. Movements and distributions are probably most impacted by human induced barriers. The effects of natural

physiographic or vegetative gaps on movement and distribution of wolverine has not been determined. Timing of wolverine dispersal can be critical. Male wolverines may attempt to disperse from the natal area at maturity during the period from early February through May (Copeland and Harris 1994).

Methodology: Identify and map linkage zones and potential barriers to movement or residency. Intensive post-release monitoring of wolverine populations may refine identification of barriers and linkage zones associated with population expansions. Protection of potential linkage zones and mitigation of barriers will help ensure the widest use of potential habitat. Attempt to mitigate factors which may change a semipermeable barrier to a temporal barrier or remove the barrier altogether. Protection of linkage zones is most important during the juvenile dispersion periods.

Objective 3: Select suitable reintroduction areas for release sites to ensure the best chance of a successful reestablishment. Selected habitats should have linkage to other suitable habitats to ensure an expanding population will be able to colonize to new areas.

Assumption: The largest areas of contiguous or linked habitat meeting the requirements of core habitat would be the best areas for a successful recovery. These sites would be chosen as release sites. Since the potential carrying capacity of the habitat is not known for Colorado, home ranges should be calculated conservatively. Initially we will select areas >2,000 km^2 (1200 mi^2).

Methodology: Using GIS mapping, identify the best potential habitats using roadless areas, vegetation and historical information as the basis for the process. Review selections with WAT.

Objective 4: Refine habitat criteria during post-release monitoring.

Assumptions: Intensively monitoring radio transmitter implanted wolverine will provide information on habitat preference including denning sites, kit rearing habitat, forage areas, linkage zones and barriers.

Methodology:

1. Locate each wolverine and record time, date, vegetation, slope, aspect, elevation and UTM coordinates of each location 3 times a week for the first 60 days after release and then 2 times a week until the transmitter fails or a mortality is recorded.
2. Analyze location data to determine preferred habitats, denning areas, kit rearing areas, and linkage zones.

Objective 5: Refine habitat needs recommendations based on information collected from released wolverine.

Assumptions: Post-release monitoring will provide information on habitat preferences specific to Colorado and can be used to refine habitat protection recommendations.

Methodology:

1. Analyze habitat preference data gathered post-release to determine if conflicts exist that would jeopardize the recovery of wolverine in Colorado.
2. As habitat information changes, the Conservation Strategy should be modified as necessary.

Conservation Actions

Species Reestablishment

Assumption: To reestablish and maintain a long-term metapopulation of wolverine in the SRM we may have to transplant wolverines into suitable habitats and monitor their activity and survival.

Methodology:

1. Identify suitable core habitats for reintroduction areas as discussed in Habitat Goals and Objectives.
   a. Determine potential carrying capacity for core areas centered on refugia of high alpine cirques and estimate the number of animals to be released into the core areas.
   b. Prioritize release sites using overall size of core areas, potential denning sites, and linkage zones to other core areas and the extent of adjacent maintenance areas as criteria.
   c. Choose at least 2 release sites yearly in or adjacent to the best core habitats in 1998 and 1999. The exact number of release sites will be determined by the number of wolverines captured for transplant and the carrying capacity of the core areas. The initial plan calls for 50 wolverine per year for 2 years.
2. The release of the animals will be evaluated by the WAT and they will recommend a procedure. At this time it appears a soft release may be the best technique. In a soft release, holding facilities would be built at release sites. Wolverines are believed to have complex social behavior and holding individuals that will use the same core area together for a period of time may reduce dispersal from the core area.
3. The sex ratio in the wild is close to 1:1 (Banci 1994). In the transplanted animals a sex ratio of more than one female per male would be preferred. Males usually have 2 to 6 females in their home range. Males tend to disperse more frequently and for longer distances than females. The dispersal of young females is likely the limiting factor in the recovery in vacant habitats (Banci 1994). This would imply that transplants should be done in different parts of the state to ensure females are established in suitable core habitats.
4. If possible, obtain wolverine from habitats similar to Colorado's mountainous terrain. Wolverines occupying different ecoprovinces differ in body size and behavior. This variation may represent local adaptation and may have important conservation implications (Banci 1994).

5. Implant radio transmitters and collect hair and blood samples for DNA analysis from each wolverine. Have each animal inspected by a veterinarian prior to release.
6. Release wolverine before denning to enable pregnant females to find denning sites.
7. Intensively monitor wolverines after the release. Each wolverine will have a radio transmitter that will identify the individual. In the first 60 days after release each animal will be relocated 3 times a week. Thereafter each animal will be located twice a week or until the transmitter fails or a mortality occurs. Any mortalities will be investigated to determine the possible cause of death. Wolverine relocations will be stored in a data base as UTM coordinates. Later analysis will indicate potential habitat preferences for denning, rearing, foraging and linkage zones. In addition reproductive data would be monitored.

Evaluation

Research will be conducted to investigate wolverine survival, dispersal, reproductive success, and habitat preferences.

Mapping of Potential/Suitable Habitat

The habitat preferences will be identified and mapped in WRIS or compatible computer system. The model used to select habitat blocks will be verified and adjusted to reflect the data collected through the radio telemetry. This model will be used to identify blocks of potential habitat located throughout the region.

Habitat Needs/Enhancement

Habitat blocks will be identified as potential key wolverine areas. These areas should be validated, site-specifically. As new habitat needs information is identified, recommendations should be made to adjust this conservation strategy.

Approximating the natural disturbance frequency and spatial patterns present on the landscape is expected to provide reasonable habitat for wolverine. Several National Forests in Colorado have developed Range of Variation documents (Arapaho-Roosevelt, White River, Routt, and Rio Grande) which discuss local ecological patterns. Timber harvest, stand thinning, grazing management, artificial regeneration, and prescribed fire are some examples of appropriate tools to achieve certain habitat objectives.

In some areas wolverines in alpine and sub-alpine habitats may be subjected to disturbance from intense recereational activity in the spring and summer. This disturbance may impair kit survival if females are forced to use less secure den sites. Recreational activity may be a concern if den sites are limiting because wolverine have been relegated to high elevation areas due to extensive habitat loss and alteration (Banci 1994). Access management plans may need to consider all-terrain vehicles and travel on foot and horseback to protect known female den sites.

Until more information becomes available, habitat management prescriptions that successfully provide for the needs of species and their prey will also provide for the needs of wolverine at the stand level. However, it is not known whether this will provide for wolverine habitat needs at the landscape or larger scales (Banci 1994). As additional information is obtained, interim guidelines will be modified as necessary.

Research

The radio telemetry relocations from the wolverine will provide data on a scale that has never been evaluated for this rare and reclusive species. During the course of this reintroduction those issues that are identified as critical to the recovery will be evaluated for future investigations. The most important questions should receive preference for research funding.

INFORMATION AND EDUCATION

Public support for the reestablishment of wolverine is essential to its success. Public support is contingent upon 4 ingredients: 1) widespread public awareness and understanding of conservation goals, objectives, and strategies, 2) evidence of careful assessment of biological, economic, and political risks, 3) evidence of significant public support and/or approval for the woverine conservation strategies and expected outcomes, and 4) justification for an affirmative reestablishment decision.

Widespread public awareness and understanding of the conservation strategy will be achieved in 3 ways. A draft of the conservation strategy will be released to the public via a "meet the public forum" which will include members of the press and interested members of the public. Copies of the conservation strategy will be mailed to all organizations currently listed in the mailing lists of the cooperating agencies (Colorado Division of Wildlife, U.S. Forest Service, U.S. Fish and Wildlife Service, and the National Park Service). Additional copies will be available upon request. Public meetings will be scheduled to review the contents of the conservation strategy with those in attendance and to respond to questions and suggestions for revision. Lastly, the cooperating agencies will issue periodic news releases summarizing the contents of the conservation strategy and progress towards its implementation.

Evidence of the biological, economic, and political credibility of the conservation strategy will come from rigorous peer review of the document by recognized authorities who have no affiliation with the conservation program. In addition, extensive public review will provide additional opportunities for technical reviews of the proposed conservation strategy.

Evidence of significant public support will follow from the implementation of an incremental phase public involvement model (Fig. 5). The incremental phase model is designed to include public input only to the extent necessary to demonstrate and/or secure significant public support for a proposed management or policy decision. Phase one aims at raising public awareness and understanding of a proposed public policy or management action. It is achieved through extensive and inclusive public information campaigns and evaluated by direct public responses or comments during public meetings and written comments received from reviews of drafts of the conservation strategy. If no significant public opposition to the proposal results from phase one activities, widespread public support (or at least minimal opposition) to the proposal is assumed and no further public involvement is required. If, however, significant public opposition or concern results during phase one, public involvement is incremented to phase two.

Phase two aims to engage the public in significant deliberation over contested issues and/or alternatives that result from phase one. In the case of the wolverine conservation strategy, public deliberation will be implemented via an interactive public survey instrument which not only asks

the respondents to reply to specific questions, but which also engages them in interactive dialogue with the interviewer to develop resolutions to outstanding questions, issues, and conflicts (Kathlene and Martin 1991; Fishkin 1993, 1995). Upon completion of the deliberative public survey, the conservation strategy will be revised and redistributed to interest groups and the public-at-large for further comment. If no significant public opposition results from the revised proposal, public support for the revised conservation strategy will be assumed and active solicitation of public involvement will terminate. If significant public opposition prevails even after phase two, public involvement will increment to phase three.

Phase three is a public collaboration phase which calls for the formation of a stakeholder process to engage stakeholders in substantive discussions and debates to resolve outstanding issues and conflicts. Stakeholders will include representatives from interest groups, agencies, and the public-at-large and would be charged with developing consensus alternatives to resolve outstanding issues with the draft conservation strategy (examples of comparable deliberative processes can be found in Maguire and Boiney 1994, Curtis and Hauber 1997, Guynn and Landry 1997, Merkhofer et al. 1997, Moote et al. 1997, Steelman and Ascher 1997). In the event that the stakeholders can not reach consensus on ways to resolve outstanding issues, public involvement will increment to phase four.

Phase four is a decision phase which is specifically designed to yield public decisions over issues where stakeholder deliberations become stalemated. Brown et al. (1995) refer to this process as a *values jury* approach to public decision-making. A values jury consists of 20-40 randomly selected adult citizens who hear competing arguments and evidence concerning conflicting policy or

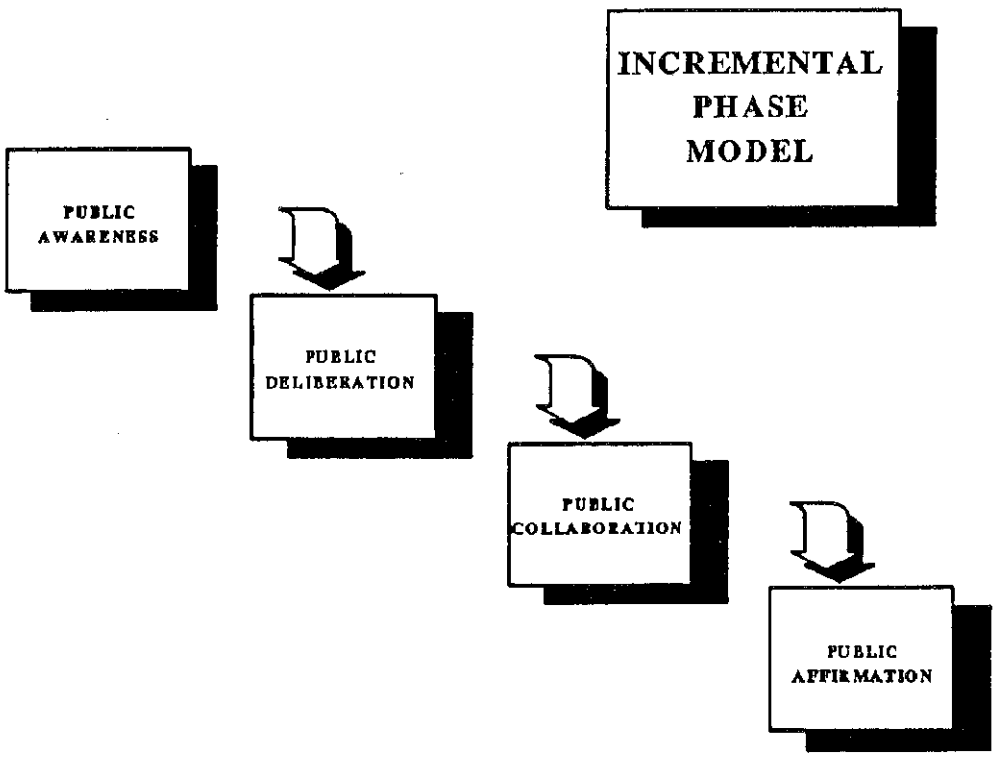


Fig. 5. Incremental phase model for effective public involvement in management decisions.

management alternatives. The jury then decides which of the competing alternatives to implement analogous to the way a judicial jury decides contested issues of law. Decisions made by the values jury concerning conflicts with the content of the draft conservation strategy would be ratified and/or modified by the agency decision makers and incorporated into the final conservation strategy.

LAW ENFORCEMENT

The current status:

Colorado Revised Statue 33-2-105 provides for the Wildlife Commission to establish a list of those species or subspecies of wildlife indigenous to this state which are determined to be endangered or threatened with this state.

Wildlife Commission Regulation, Chapter 10, Nongame Wildlife, Article II Endangered Wildlife, #1002 Designation of Species further provides the listing of species determined to be endangered in Colorado. This list includes wolverine (*Gulo gulo*).

Colorado Revised Statue 33-6-110(a), sets the fine for take or possession of wolverine in Colorado at $1,000.00.

No new regulations are proposed at this time.

ACTION PLAN

Activity	Parties Responsible	Proposed Date	Cost
Prepare Draft Conservation Strategy	Wolverine Conservation Team	December 1, 1997	$1,600 CDOW $????
Begin Public Involvement	Wolverine Conservation Team CDOW/USFS/FWS/NPS	December 1997	$200 CDOW
Conduct habitat assessment	CDOW, USFS, NPS volunteers	Dec 1997-Sep 1998	$8,000 not funded
Survey SRM by GIS. of all roadless, Wilderness.	CDOW,USFS,NPS	Dec 1997-Mar 1998	$????
Map suitable habitat	CDOW/USFS/NPS	Dec 1997-Sep 1998	$?????
Select Core areas	CDOW Research	September 1998	$2,000 not funded
Select 2 release sites from best Core areas	CDOW, WAT	October 1998	$2,000 not funded
Public review of habitats and Reestablishment Plan	CDOW/USFS	Oct/Nov 1998	
Obtain/release wolverine	CDOW, WAT	Winter 1998 to 2001	$75,000 not funded
Begin monitoring	CDOW	Upon release	$109,650 notfunded $100,000 CDOW
Modify habitat criteria	CDOW, USFS	Post-monitoring	
Identify potential habitat		Post-monitoring	
Review & revise Cons. Strategy	Wolverine Conservation Team	As needed	$200 not funded

WOLVERINE FUNDING

A draft budget has been prepared and is included in Appendix B. This budget indicates that over a 3-year period accomplishment of the objectives outlined in this proposal would require funds estimated at $960,000 for wolverine reintroduction. The CDOW has committed to fund $250,000 of this effort. It is proposed that $710,300 will need to come from private sources.

SOCIAL AND ECONOMIC ISSUES

All the social and economic issues have not been identified at this time. These issues will be addressed through each agencies' unique planning processes as they implement the recommendations of the strategy. The identification of these issues will begin with the release of this document. The first issue will be, should wolverine be reestablished in Colorado and at what cost?

REVISION OF CONSERVATION STRATEGY BASED ON NEW INFORMATION

The Conservation Strategy will be revised as new information becomes available from this reestablishment and from other studies being conducted on this species and its ecology.

GLOSSARY

Definitions

1. Semipermeable barrier. Landscape comprised of avoided habitats, frequent ecological or behavioral disturbance, or attempts at residency with probability of low success. Examples include:
   a. Large expanses of lowland habitats
   b. Expansive tracts of agriculture, metropolitan/urban areas or timber harvest.
   c. Areas of intensive human activity, e.g., ski areas, heavily used roads and housing development.
2. Temporal barrier. Semipermeable barrier of a seasonal nature, e.g., snowmobiling, or other seasonal or infrequent human use.
3. Core or key habitat. Those areas of the state that provide important habitat requirements relating to seclusion, reproduction and kit rearing, spatial and social requirements and foraging habitat.
4. Maintenance habitat. Those areas of the state that support rearing of young, spatial and social requirements, foraging habitat and ensure connectivity of subpopulations.
5. Metapopulation. A loose confederation of sub-populations that do not routinely disperse among themselves, but are close enough that dispersal can repopulate areas following local extinction. If dispersal is routine, these are not sub-populations.
6. Candidate. A plant or animal taxon native to the United States that is being reveiwed for possible addition to the list of endangered and threatened species under the Endangered Species Act of 1973, as ammended. This decision is made by the Secretary of the Interior.
7. Sensitive species. A classsification used by U.S. Forest Service to identify taxa where species and or habitat are declining, and continued loss could lead to federal listing as threatened or endangered, or a species population or habitat is stable but limited.

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APPENDICES

APPENDIX A

1997 LYNX/WOLVERINE RECOVERY TEAM

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APPENDIX B

LYNX AND WOLVERINE REINTRODUCTION COSTS

Activity	Fiscal Year	Lynx Reintroduction			Wolverine Reintroducton		
		Habitat Assessment Phase	Reintroduction Phase	Post-release Evaluation Phase	Habitat Assessment Phase	Reintroduction Phase	Post-release Evaluation Phase
GIS Data Assessment	1998	*$ 1,500*[1]					
On-ground Habitat Assessment	1998	*$ 25,500*					
	1999	$ 31,200			$ 12,000		
Live capture	1999		$ 75,000			$ 75,000	
	2000		$ 75,000			$ 75,000	
Veterinary inspections prior to transport	1999		$ 1,500			$ 900	
	2000		$ 1,500			$ 900	
Air transportation costs	1999		$ 29,000			$ 17,400	
	2000		$ 29,000			$ 17,400	
Soft-release pen construction and animal maintenance	1999		$ 86,400			$ 86,400	
Pre-release disease screening	1999		$ 5,000			$ 3,000	
	2000		$ 5,000			$ 3,000	
Radiocollars, receivers, and labor for ground tracking	1999			$ 42,500			$ 31,500
	2000			$ 34,000			$ 31,500
DNA analysis	1999			$ 5,000			$ 3,000

APPENDIX B (Continued)

	2000			$ 5,000			$ 3,000
Aircraft expenses	1999			$345,600			$172,800
	2000			$345,600			$172,800
Vehicle mileage and expense	1999			$ 2,400			$ 1,350
	2000			$ 2,400			$ 1,350
Snowmobile replacement	1999			$ 10,000			
Snowmobile operation and maintenance	1999			$ 1,500			$ 1,000
	2000			$ 1,500			$ 1,000
DOW Contribution (Salaries, Equipment, etc.)	1999			*$150,000*			*$ 100,000*
	2000			*$ 95,000*			*$ 45,000*
	2001			*$ 60,000*			*$ 35,000*
	2002			*$ 60,000*			*$ 35,000*
	2003			*$ 60,000*			*$ 35,000*

Totals by Species by Fiscal Year	1998	*$ 27,000*	$ 0
	1999	$785,100	$504,350
	2000	$594,000	$350,950
	2001	*$60,000*	*$ 35,000*
	2002	*$ 60,000*	*$ 35,000*
	2003	*$ 60,000*	*$ 35,000*

Totals by Fiscal Year	1998	$ *27,000*
	1999	$1,289,450
	2000	$ 944,950
	2001	$ *95,000*
	2002	$ *95,000*
	2003	$ *95,000*

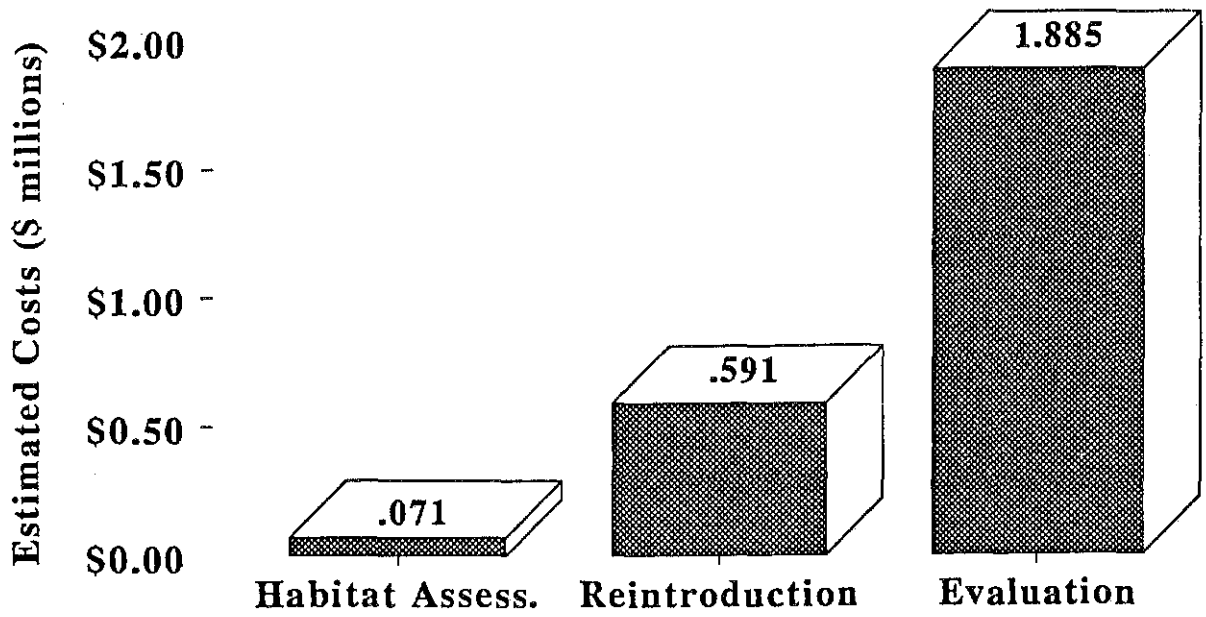
Totals by Phase	Habitat Assessment = $ 70,200	Reintroduction = $ 591,100	Post-release Eva lation = $1,885,100

Totals by Contributor by Species	Colo. Div. Wildl. Lynx Contribution = *$ 452,000* Colo. Div.Wildl. Wolverine Contribution =*$ 250,000* NonCDOW Lynx Contribution = $1,134,000 NonCDOW Wolverine Contribution =$ 710,300
Totals by Contributor	Colo. Div. Wildl. Contribution = *$ 702,000* NonCDOW Contribution = $1,866,400
Grand Total	$2,546,400

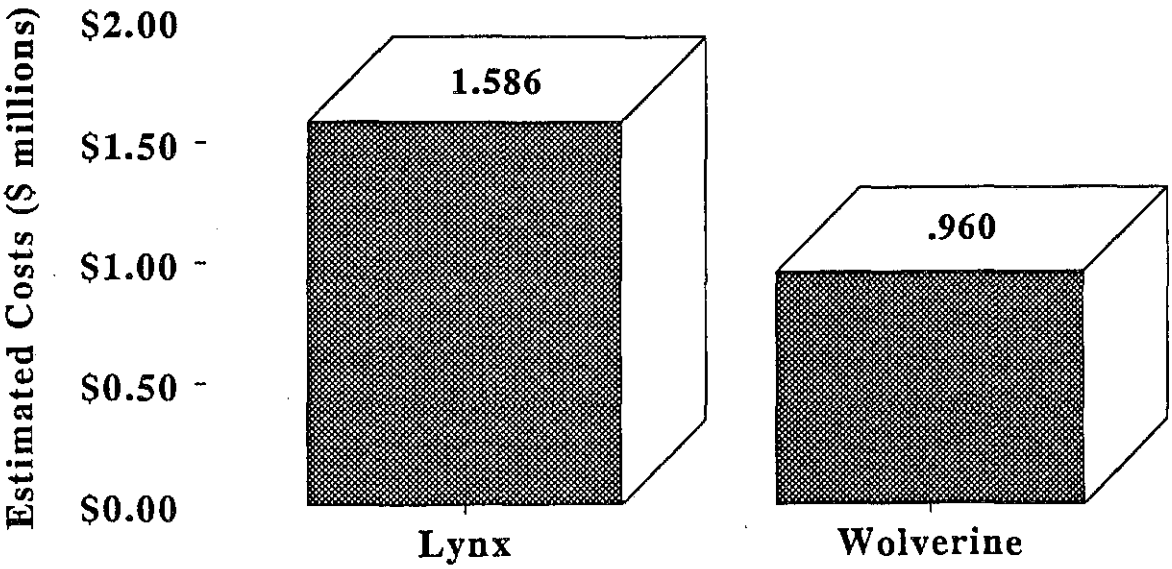
[1] Italicized figures equal CDOW contribution

APPENDIX B (Continued)

LYNX/WOLVERINE REINTRODUCTION COSTS BY PHASE



LYNX/WOLVERINE REINTRODUCTION COSTS BY SPECIES



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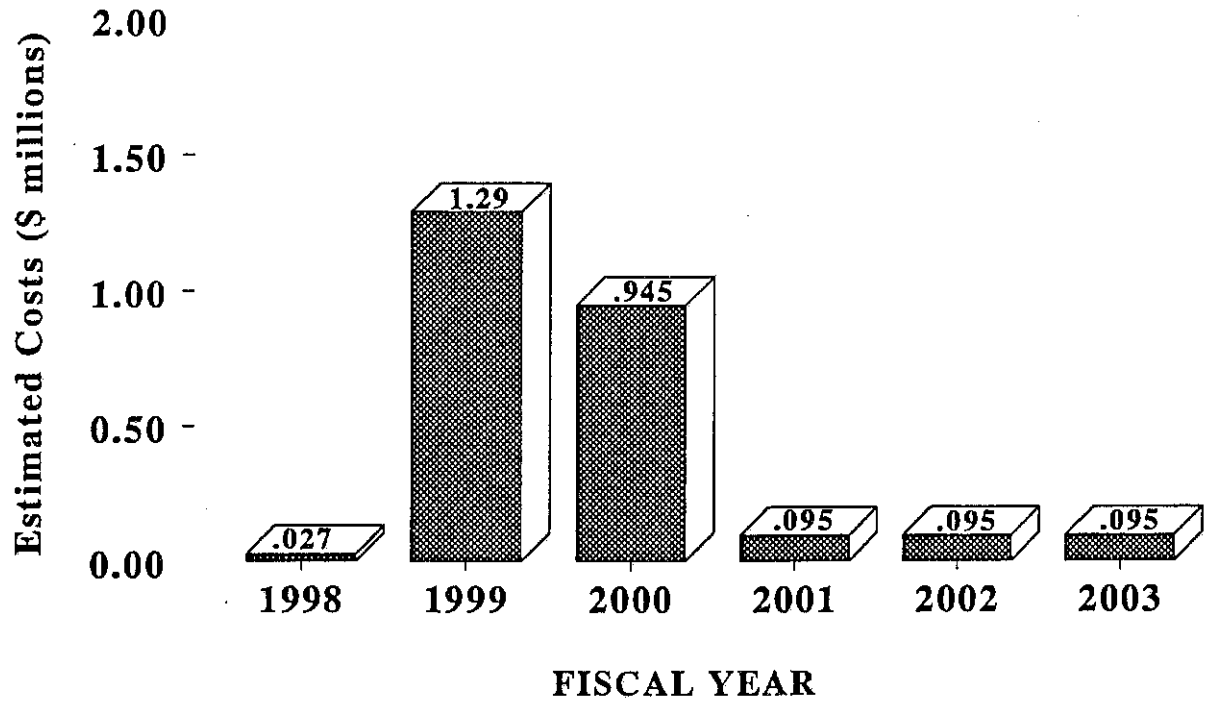
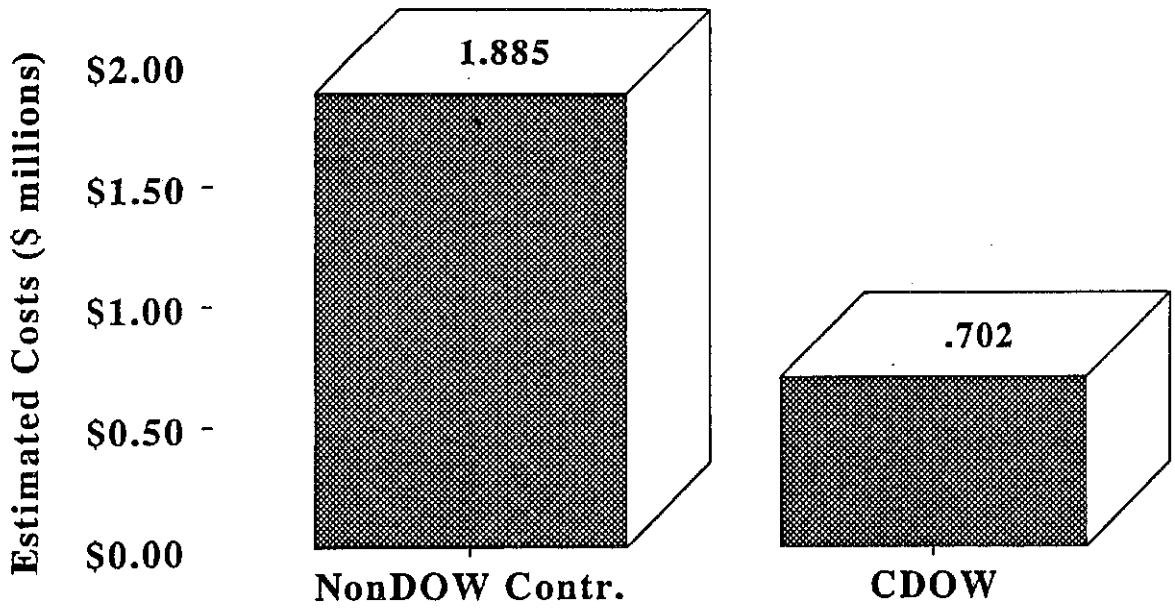
LYNX/WOLVERINE REINTRODUCTION COSTS FISCAL YEAR



LYNX/WOLVERINE REINTRODUCTION COSTS BY FUNDING SOURCE



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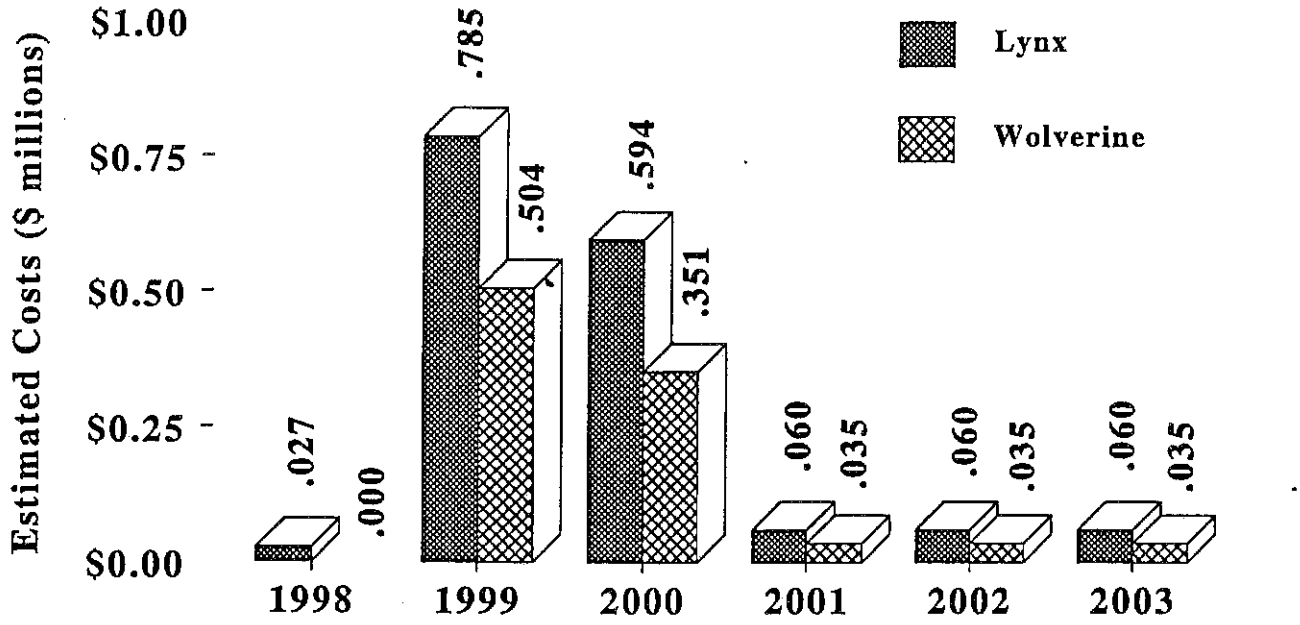
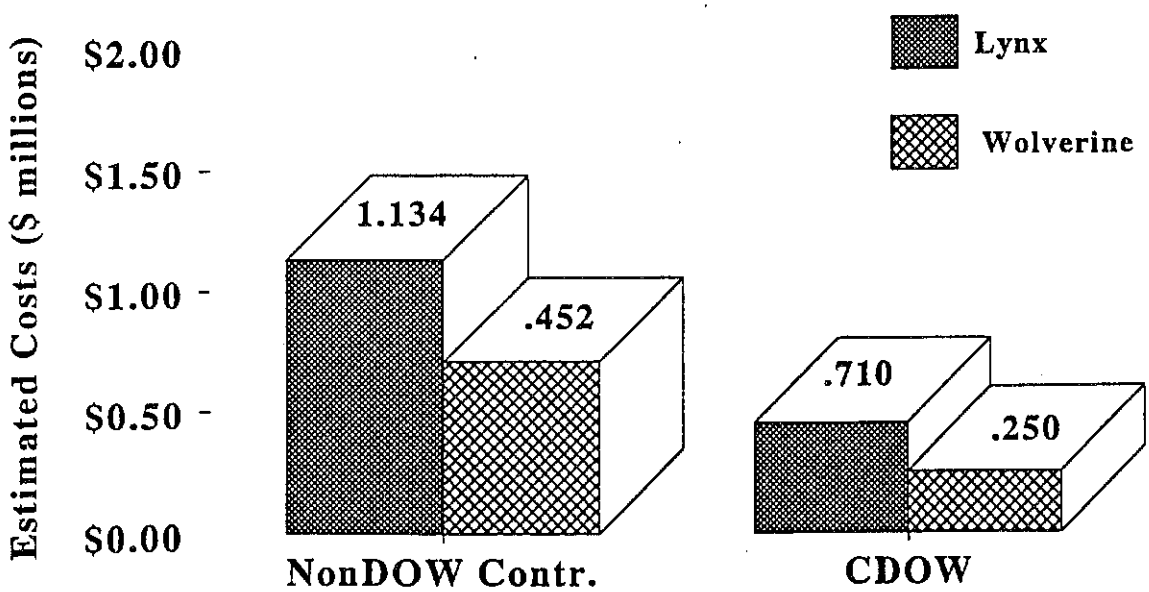
LYNX/WOLVERINE REINTRODUCTION COSTS BY SPECIES BY FISCAL YEAR



LYNX/WOLVERINE REINTRODUCTION COSTS BY SPECIES BY FUNDING SOURCE



APPENDIX C

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STATE OF COLORADO
Roy Romer, Governor
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
AN EQUAL OPPORTUNITY EMPLOYER

John W. Mumme, Director
6060 Broadway
Denver, Colorado 80216
Telephone: (303) 297-1192

APPENDIX D

August 4, 1997

TO: Interested Parties

SUBJECT: Lynx and Wolverine Recovery in Colorado

On July 8, 1997, representatives of the Forest Service, U.S. Fish and Wildlife Services and the Division of Wildlife met to discuss a cooperative program for the above listed species. We have agreed to jointly prepare "A Candidate Conservation Strategy For Lynx in Colorado." The lynx in Colorado was classified as an endangered species over 20 years ago. Since then the status has remained questionable, although no doubt, the species is near extinction in the State.

We have agreed to take action under the umbrella of the Memo of Agreement (MOA) signed by the Secretary of Interior and the Governor of Colorado. Since the wolverine occupies much of the same habitat it would be advisable that this be included as well.

We have agreed to utilize existing information as a foundation for the document. For example, information contained in "Managing Forested Land for Wildlife," the information in the 1979 Sikes Acts Plan for Colorado, information from Washington and Idaho, as well as data collected in the vicinity of Vail.

The Colorado Division of Wildlife will take leadership in coordinating this effort and has assigned Gyne Byrne as lead with assistance from Dale Reid and Tom Beck. The Fish and Wildlife Service has identified Steve Berlinger, the National Park Service has named Craig Axtell as their representative, and the Forest Service has named Kit Buell as its representative to this technical working group.

APPENDIX D (Continued)

The core working group will prepare a "Candidate Strategy Conservation Plan." The draft will be available by December 1, 1997, and include a broad site recommendation for potential re-introduction.

Elizabeth Estill
U.S. Forest Service

Randy Jones
National Park Service

for Ralph Morgenweck
U.S. Fish and Wildlife Service

John W. Mumma
Division of Wildlife

cc: Leadership Team
Jim Lochhead

APPENDIX E

Text of Proposal – Amendment 14
PROHIBITED METHODS OF TAKING WILDLIFE

Be it Enacted by the People of the State of Colorado:

Article XVIII of the Constitution of the State of Colorado is amended by the addition of a new Section 12, to read:

Section 12. Prohibited methods of taking wildlife. (1) It shall be unlawful to take wildlife with any leghold trap, any instant kill body-gripping design trap, or by poison or snare in the state of Colorado.

(2) The provisions of subsection (1) of this section shall not prohibit:

(a) The taking of wildlife by use of the devices or methods described in subsection (1) of this section by federal, state, county, or municipal departments of health for the purpose of protecting human health or safety;

(b) The use of the devices or methods described in subsection (1) of this section for controlling:

(I) wild or domestic rodents, except for beaver or muskrat, as otherwise authorized by law; or

(II) wild or domestic birds as otherwise authorized by law;

(c) The use of non-lethal snares, traps specifically designed not to kill, or nets to take wildlife for scientific research projects, for falconry, for relocation, or for medical treatment pursuant to regulations established by the Colorado wildlife commission; or

(d) The use of traps, poisons or nets by the Colorado division of wildlife to take or manage fish or other non-mammalian aquatic wildlife.

(3) Notwithstanding the provisions of this section 12, the owner or lessee of private property primarily used for commercial livestock or crop production, or the employees of such owner or lessee, shall not be prohibited from using the devices or methods described in subsection (1) of this section on such private property so long as:

(a) such use does not exceed one thirty day period per year; and

(b) the owner or lessee can present on-site evidence to the division of wildlife that ongoing damage to livestock or crops has not been alleviated by the use of non-lethal or lethal control methods which are not prohibited.

(4) The provisions of this section 12 shall not apply to the taking of wildlife with firearms, fishing equipment, archery equipment, or other implements in hand as authorized by law.

16-Dec-97

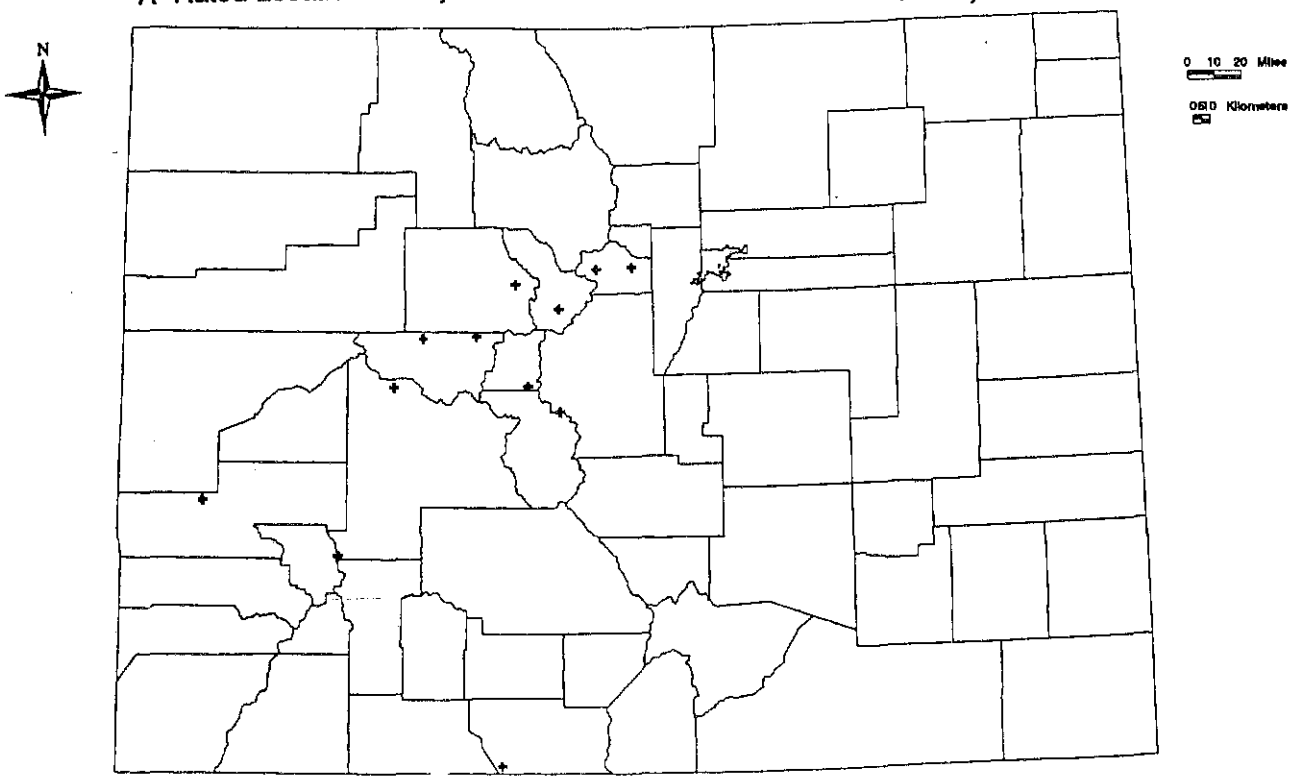
COLORADO LYNX AND WOLVERINE INVESTIGATIONS

INVESTIGATORS	TIME PERIOD	METHODS					AREA SURVEYED	RESULTS
		TRACKS (MI) (FLIGHT HR.)	CAMERA (NIGHTS) (STATIONS)	TRAP NIGHTS	HAIR SNAGS (SNAG NIGHTS OR NUMBER)	POSTERS		
Anderson C. 1991	Winter 90-91	no data		686			Vail Ski area, Battle Mt.	2 possible lynx tracks
Andrews, T. 1991	Winter 90-91	848 mi.					RMNP, Arapaho/Roosevelt N. F.	no wolverine or lynx
Andrews, T. 1992	Winter 91-92	2053 mi.					Vail, Adams Rib, Snowmass ski areas	1 possible lynx track
Byrne G. & J. Copeland 1997	Winter 96-97	22.75 f.h.					10 likely sites in CO	10 possible wolverine, 2 possible lynx
Carney, I. 1993	Winter 92-93	1353 mi.					CO historic sites	1 possible lynx
Halfpenny J., S. Bissell & D. Nead 1982	Winter 79-80	30 days			40 snags	3,000	likely sites in CO	8 lynx tracks (4-7 indiv.), doc. wolv. shot near Dinosuar
Kenvin, D. 1993a	Summer 1992		60 stations				W. side of San Luis Valley	896 slides but no lynx or wolverine
Kenvin, D. 1993b	Summer 1993		1230 nights, 60 sta.				Rio Grande & S. San Juan N. F.	0 lynx & wolverine, 336 animal pictures
Kenvin, D. 1995	Winter 94-95		50 sta.				Rio Grande, Gunnison, San Jauan N. F.	0 lynx or wolverine
Reichert, C. 1997	3 Winters 4-95 to 4-97		6+ stations				Flat Tops - Trappers L. to Burro Mt.	no lynx or wolverine lot of bear, marten, coyote, racoon. etc.
Thompson R. & J. Halfpenny 1989	Winter 88-89	190.5 mi.					Vail Ski & expansion area	lynx tracks - 5 poss., 2 prob., 2 positive
Thompson R. & J. Halfpenny 1991	Winter 90-91	339.2 mi.					proposed E. Fork Ski area	1 track set (female 7 kitten)
Thompson R. (pers. commun.)	1986-87	200 mi.			UNK number		Proposed Quail Mt ski area	no lynx or wolverine
Thompson R., T. Watts & J. Halfpenny 1992	Win - Sum 91	849.8 mi.			22 snags		Proposed E. Fork Ski area	no wolverine

APPENDIX F (Continued)

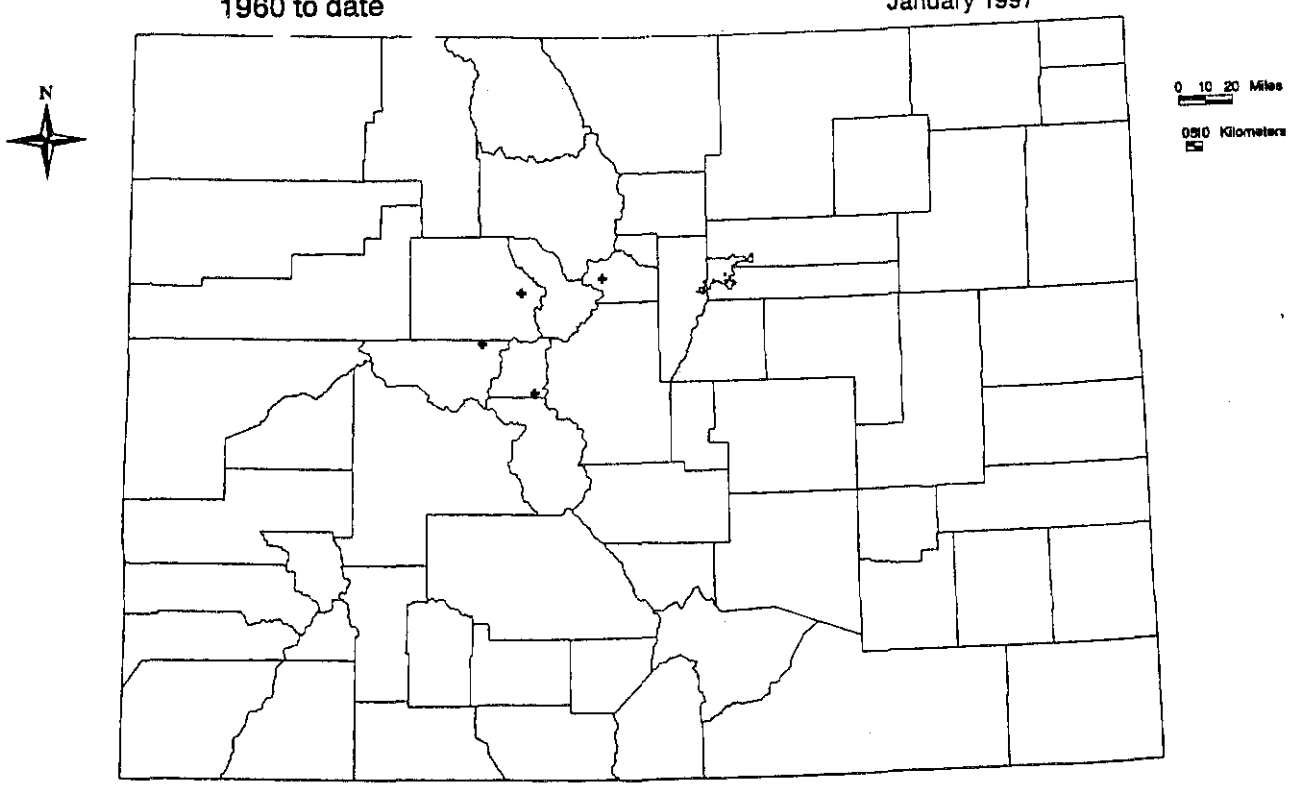
"A" Rated Locations for Lynx

Colorado Division of Wildlife
January 1997



"A" Rated Locations for Lynx
1960 to date

Colorado Division of Wildlife
January 1997



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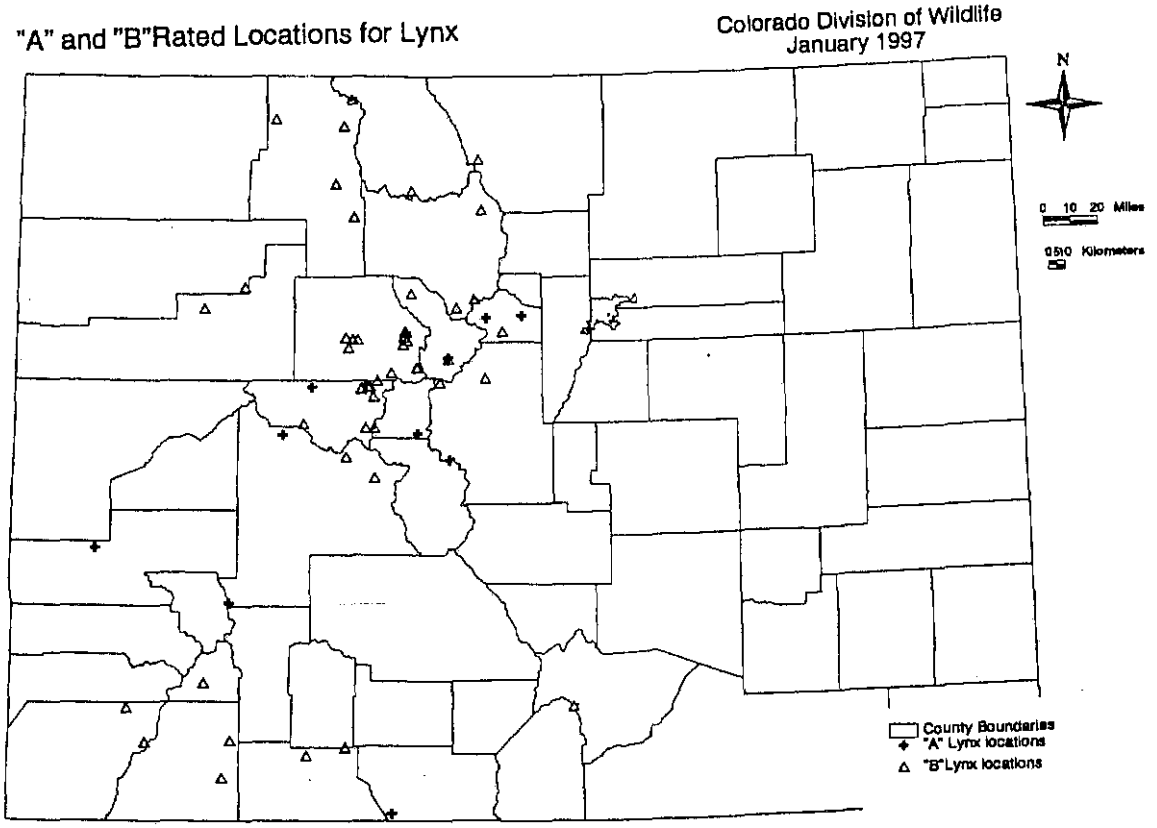

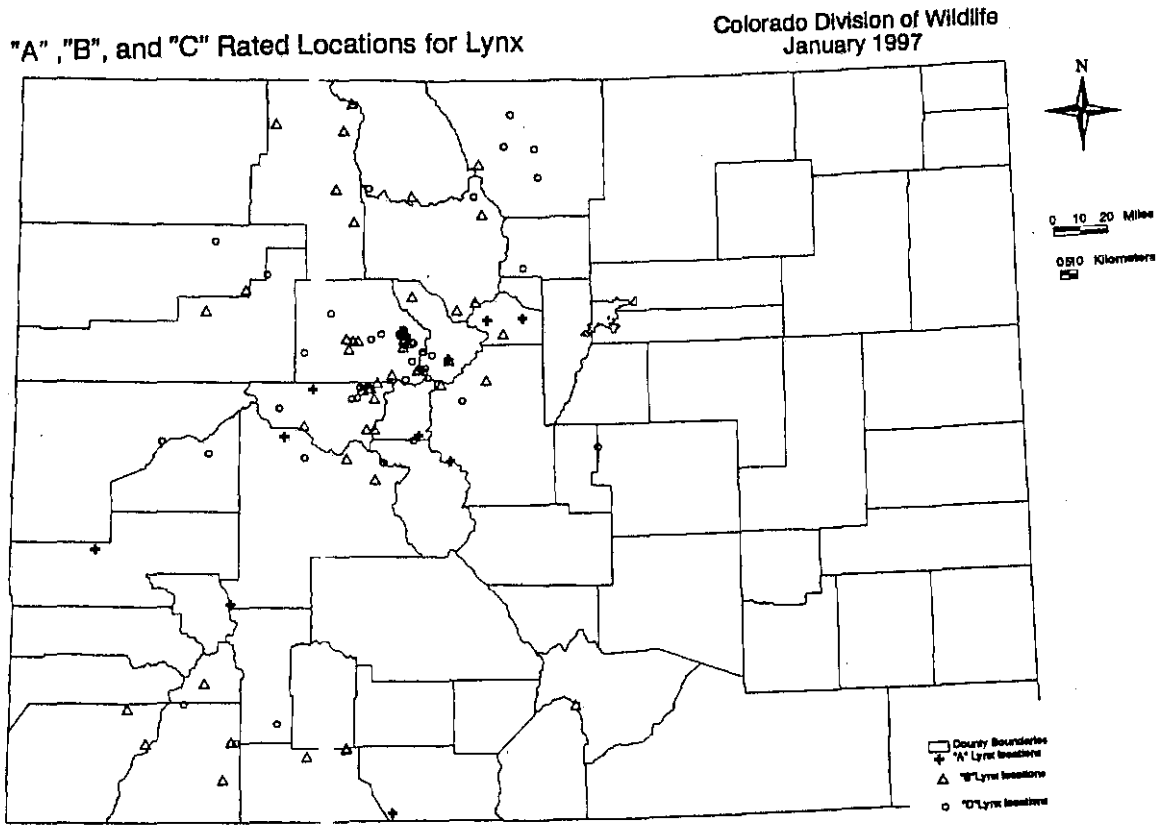

APPENDIX F (Continued)

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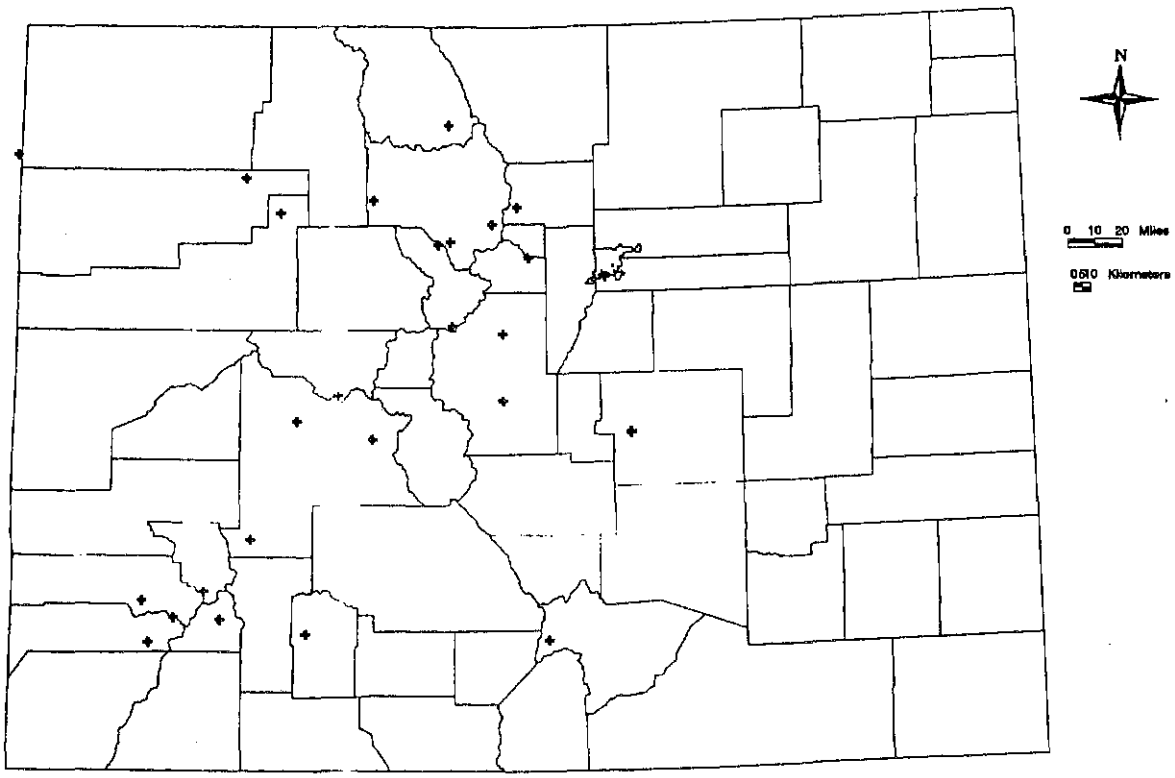
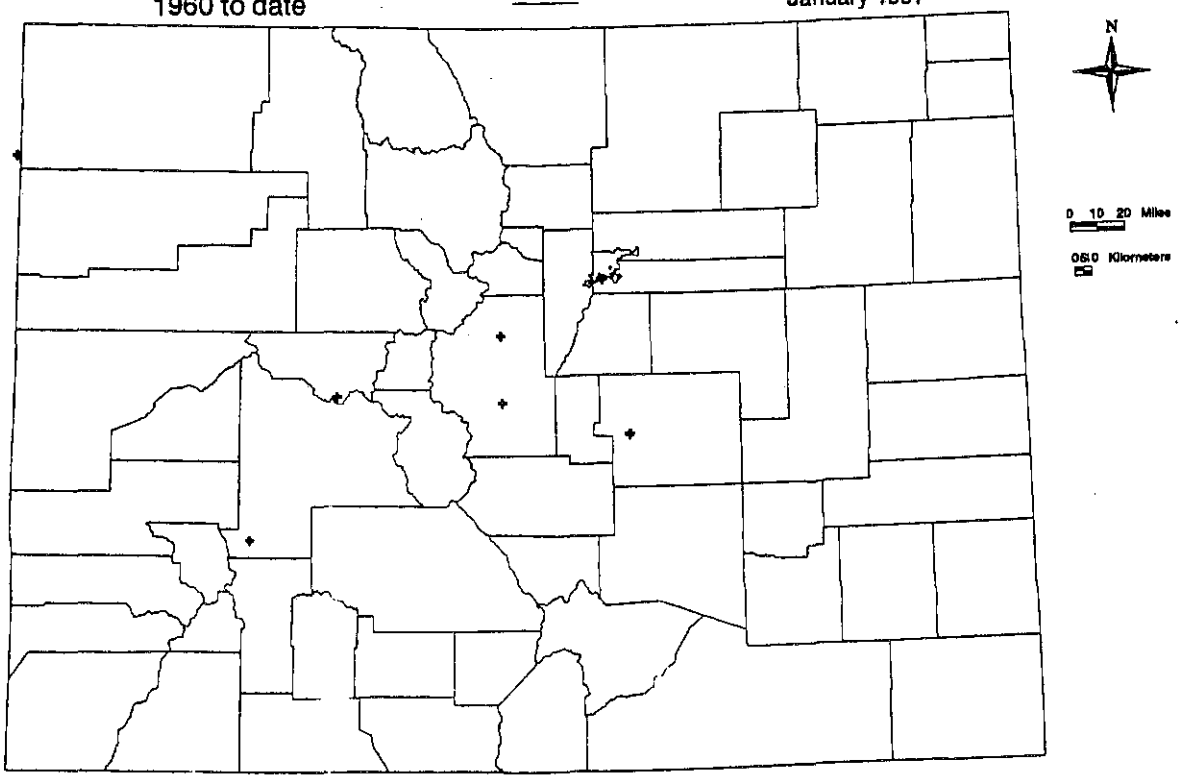
Colorado Division of Wildlife
January 1997

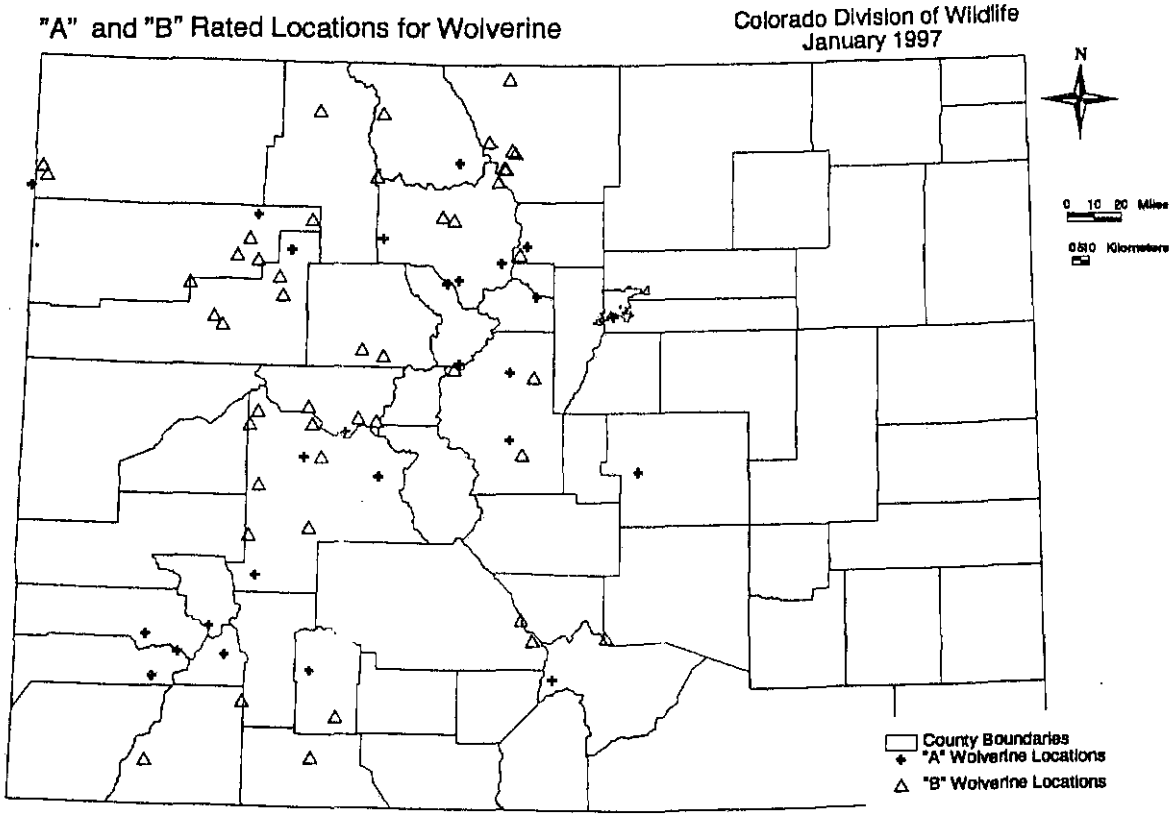


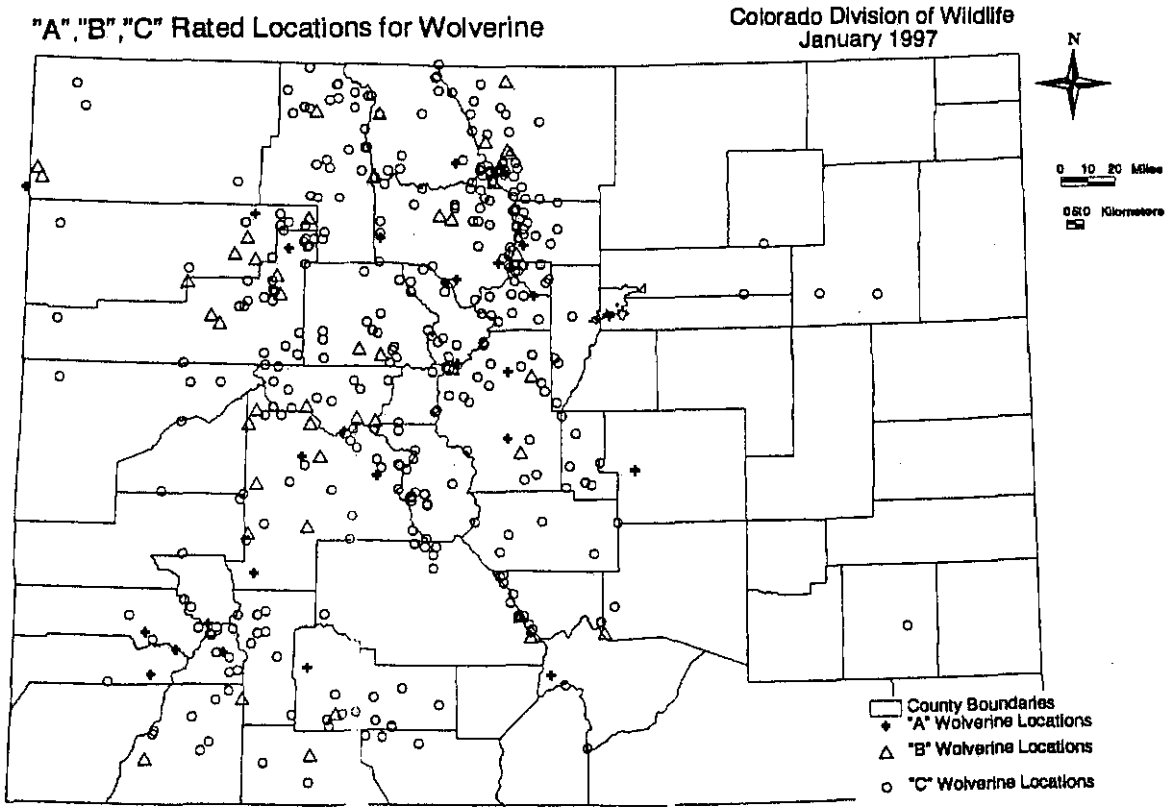
"A" Rated Locations for Wolverine
1960 to date

Colorado Division of Wildlife
January 1997

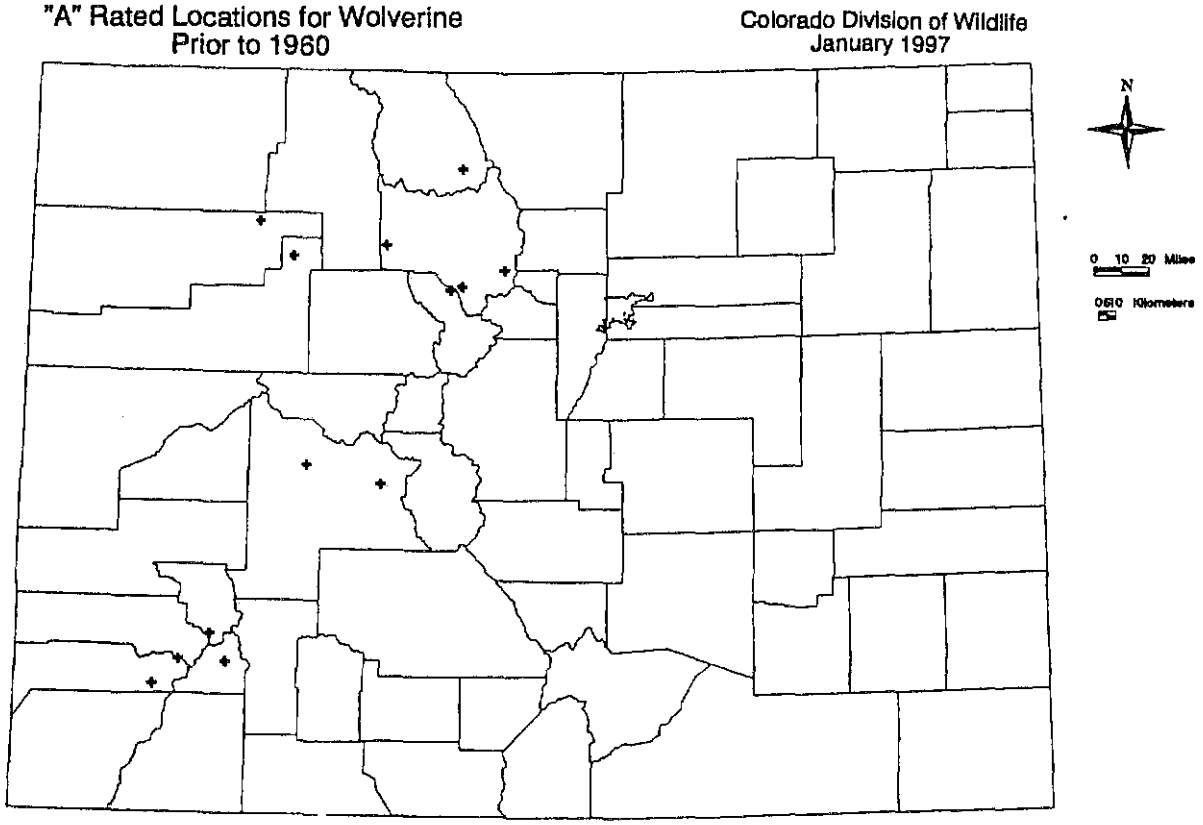


APPENDIX F (Continued)





APPENDIX F (Continued)



APPENDIX G

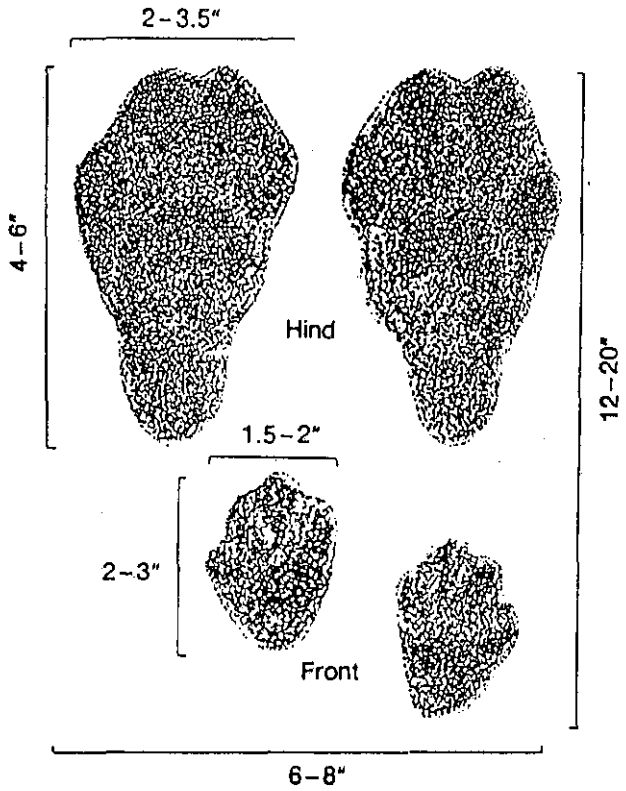
LYNX ADVISORY TEAM

Team Leader - Dr. John Weaver-Wildlife Conservation Society - Missoula, MT

1. Tactical planning - Tim Clark or Rich Reading
2. Lynx ecology - Garth Mowat/Kim Poole and Gary Kohler
3. Lynx restoration - Kent Gustafson
4. International Logistics/veterinary care - Mark Johnson
5. Colorado DOW representative - Jim Olterman
6. Canadian representative- to be determined

APPENDIX H

COLORADO SNOWSHOE HARE TRACK SURVEY PROTOCOL



Gene Byrne, Wildlife Biologist
Colorado Division of Wildlife
50633 Highway 6 & 24
Glenwood Springs, CO 81601

(970)928-8704
gene.byrne@state.co.us

Nov. 11, 1997

APPENDIX H (Continued)

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SNOWSHOE HARE TRACK SURVEY PROTOCOL

by Gene Byrne
11-17-97

INTRODUCTION: The purpose of the habitat assessment project will be to determine where the best populations of snowshoe hare (*Lepus americanus*) and snowshoe hare habitats are located in the state. The supposition being that the best snowshoe hare populations should also be the best potential lynx habitat. The snowshoe hare/lynx habitat assessment for Colorado will be a two part process. The first part will be to do a coarse filter survey of all suitable habitat in Colorado by using winter track surveys. The objectives of these surveys will be threefold: (1) determine where snowshoes are present in the state (overall range); (2) where they are most abundant (density); and (3) what overstory cover type and forest structure types are they most abundant (habitat). These surveys should be conducted during the winter of 1997-98.

The second part of the survey will be the fine filter technique. This will also be a two part process. The first part will be to re-sample the 3 or 4 best areas, as determined by the winter track surveys. The second part will be to fill in the data sampling gaps. A random sample of all areas not surveyed during the initial winter track survey will be selected. These areas could include wilderness and inaccessible areas that could not be surveyed due to logistics or danger (avalanches, etc.). Krebs snowshoe pellet plots will be used in the second survey (Krebs et al. 1987). This work should be conducted during the summer and fall of 1998.

Step to conducting snowshoe hare track surveys:

A. **Select Broad Areas** - Using GIS vegetation maps, randomly select areas around the state that have the following habitats:

- Coniferous forests - lodgepole pine, Engelmann's spruce, subalpine fir, Douglas fir - other forest types could include ponderosa pine, limber pine, bristlecomb pine, and white fir.
- Aspen
- Gamble's oak and mixed mountain shrub
- Willow (high elevation riparian)
- Mixture of all above habitats

B. **Select Specific Areas** - Each CDOW area biologist, whose area includes some of the shaded area on the snowshoe hare potential distribution map (Fig. __), should select 1-2 routes per DWM district that have at least one or more or a combination of the above listed habitat types. Factors to consider when setting out the track survey transects:

- Type Survey Transportation - snowmobile, ski, snowshoe, 4X4 truck, ATV
- Sample Unit - an individual sample unit will be a 1/4 mile long transect
- Length of transect - recommend a minimum of 5 miles up to 25 miles (20 to 100 - 1/4 mile sample units)
- Select secondary roads or trails that have narrow right-of-way cuts (less than 100 ft. wide preferred)
- Select closed roads or lightly traveled roads
- Select transects that will stay in the forested or cover type for a major portion of the transect and not cross a lot of open areas/parks. Transects that cross large open areas will not be included as a sample units if more than 50% of the sample unit contains open areas that are greater than 100 ft. from the forest cover.
- Selected routes will be delineated on a map with scale of a minimum of ½ inch per mile. The maps will later be digitized in a GIS system to facilitate data analysis.

C. **Conduct Transects** - The following protocol will be used to conduct the survey

- Survey will only be run 24-48 hours after a fresh snowfall.
- Only count tracks that cross the transect from right to left or tracks that parallel either side of the transect but don't cross the route. If tracks parallel the transect route but do not cross the transect, only count one set of tracks per 160 meters. Dolbeer & Clark (1975) found that the approximate diameter of one snowshoe hare's

APPENDIX H (Continued)

home range, if it was circular shaped, would be approximately 160 m. in diameter.

- Stop and tally all the tracks every 1/4 mile (one sample unit). This distance can be determined by three methods (in order of preference): 1) measured with an odometer (4X4, snowmobile or vehicle route), 2) determined by map inspection, or 3) estimated (snowshoe or ski route).

- Determine and record the species of each set of tracks observed along the transect. Possible tracks that could be observed include: ungulates (deer, elk, bighorn sheep, moose) red squirrel, marten, canine (coyote, red fox or dog), porcupine, bobcat, mountain lion, red squirrel, grouse, etc. By inspecting all the tracks, observers will increase their tracking skills and will have less chance of missing a rare track such as a lynx or wolverine. Also, this data will increase the value of the survey by collecting the maximum amount of data with little additional effort. This will be beneficial for analyzing alternate prey species and density plus potential competition/predation problems for a future lynx re-introduction.

- For each sample unit, determine and record the average primary and secondary vegetation cover type and vegetation structure class. Vegetation types are listed above. If it the unit contains a combination of these types such a aspen and lodgepole pine, estimate which type is the most predominate, based upon percent ground cover, and then record it as the primary vegetation type. The next most common dominate vegetation type will be the secondary vegetation type. Determine and record the average structure type per 1/4 mile sample unit. Use the following categories (Hoover & Wills, 1984):
  - grass-forb stage (1)
  - shrub-seedling (2)
  - sapling-pole (3)
  - mature (4)
  - old growth (5)

- Record the average slope, elevation, aspect for each 1/4 mile sample block. Some of this data could be determined by using a topographic map back in the office after the field survey is conducted.

- Try to run the same survey route twice in the winter of 1997-98 - once in the early part of the winter and then again in late winter.

D. Some Equipment Needed to do the Surveys -

track identification guide (Halfpenny 1986, Forrest 1988)
habitat structure key
35 mm camera and film
snow track plaster cast materials
baggies (for fecal samples)
coin envelops (for hair samples, etc.)
ruler (for measuring tracks & tree DBH))
recording form
GPS (recommended)
pack set radio (recommended)
USGS topographic map
survival gear (extra clothes, food, water, matches, map, compass, space blanket, etc.)

E. Literature Cited -

Dolbeer, R. A. and W. C. Clark. 1975. Population ecology of snowshoe hares in the central Rocky Mountains. J. Wildl. Manage. 39:535-549.

Forrest, L. R. 1988. Field guide to tracking animals in the snow. Stackpole Books, Harrisburg, PA. 185 pp.

Halfpenny, J. 1986. A field guide to mammal tracking in North America. Johnson Publishing Co., Boulder, CO. 161 pp.

Hoover R. L. and D. L. Wills. 1984. Managing forested lands for wildlife. Colo. Div. of Wildlife, Denver. 459 pp.

Krebs, C. J., T. W., B. S. Gilbert, S. Boutin, and R. Boonstra. 1987. Estimation of snowshoe hare population density from turd transects. Can. J. Zool. 65:565-567.

APPENDIX H (Continued)

INSTRUCTIONS FOR FILLING OUT - SNOWSHOE HARE TRACK SURVEY FORM
11-18-97

1. Date of Survey - fill in the date that the survey was conducted.

2. GMU's - fill in the Colorado game management unit numbers for the area the survey was conducted. These can be determined from the big game regulation map.

3. County - Fill in the counties where the survey was conducted. The first county should be the county where most of the survey was conducted.

4. Page No. ___ of ____ - If more than 25 sample units are completed on this transect, use multiple forms and fill in the page number and staple the forms together.

5. Stating Location General Description .... - Give a brief narrative description of where the transect started i.e. "Start at the Elk Wallow campground 3.5 miles east of Meredith on the Frying Pan River."

6. Land Status Code - enter one of the following codes for the **average** land ownership on this transect, i.e. if 55% of the transect was on private, 30% on BLM and 15% on State Land Board the land status code would be "P".

Private - P
U. S. Forest Service - F
BLM - B
State Land Board - S
DOW - D
National Park - N
Other - O (explain)

7. If National Forest... - Write in the name of the national forest if the survey was done on national forest. If it was conducted on several forests, write the names of all the forests.

8. Survey Personnel - Write in the names of all the people who conducted the survey.

9. Start Location UTM Coordinates - write in the "X", "Y" and UTM zone (12 or 13) of the starting point of the survey.

10. End Location UTM Coordinates - write in the "X", "Y" and UTM zone (12 or 13) of the ending point of the survey. If the ending point is the same as the starting point, a loop survey, write in "same".

11. Date and Time of the Last Snowfall - Estimate the date and time of the <u>end</u> of the last snowfall. <u>Remember, to be consistent and valid, these surveys should be conducted within 24-48 hours of the last snowfall.</u>

APPENDIX H (Continued)

The Following data should be filled out for each 1/4 sample unit:

12. Primary Veg. Type - Write in the code for the average, predominate overstory vegetation type for the 1/4 mile sample unit. You will have to make this decision on what you feel is the most predominant vegetation type on the whole sample unit. This is based on greatest percent ground cover.

lodgepole pine - L
Engelmann spruce - S
subalpine fir - F
Douglas-fir - D
ponderosa pine - P
limber pine - X
bristlecomb pine - B
white fir - W
aspen - A
Gamble's oak or mixed mountain shrub - O
willow - Y
open, grass/forb or rock - Z

13. Secondary Veg. Type - Write in the code for the average, secondary overstory vegetation type for the 1/4 mile sample unit. You will have to make this decision on what you feel is the second most predominant overstory vegetation type on the whole sample unit. This type will have the second most percent ground cover on the sample unit. Use one of the codes listed above in section 12.

14. Veg. Structure Class - Write the vegetation structure class code number for the average structure class on the whole sample unit. The following narrative and diagram briefly describe forest structural stages (Hoover and Wills 1984):

(1) - **grass/forb** The grass/forb stage is created naturally by a catastrophic event, such as wildfire, and is typified by the near complete absence of snags, litter or down material in the aspen and ponderosa pine types, or vice versa in the lodgepole or subalpine forest types. The grass/fob stage lasts for relatively short periods of time, dependent upon natural vegetation and human management occurrences (i.e. grazing, recreation). A general assumption of this stage, in relation to wildlife habitat, is that it is allowed to succeed to the next structural stage (verses what occurs with conventional ski trail development). This structure is not suitable habitat for snowshoe hares and if this makes up >50% of the transect sample unit, write UNSUITABLE in the comment field.

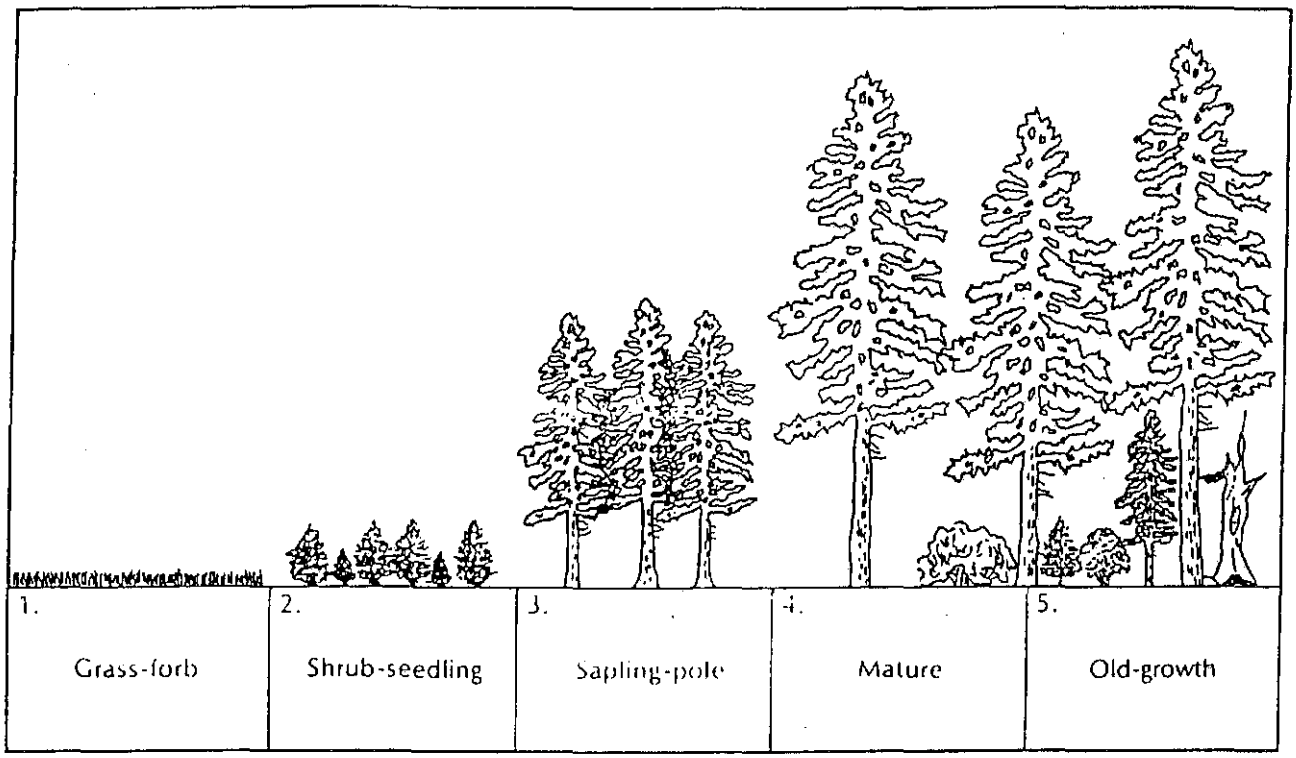
(2) - **shrub/seedling** The shrub/seedling stage occurs when tree seedlings or shrubs grow up to 1 inch D.B.H. (diameter breast high - 4.5 ft. above the ground), either naturally or artificially through planting. This stage occurs over variable periods of time commensurate to the species regenerating, site conditions, and human management occurrences (i.e. grazing, mowing).

(3) - **sapling/pole** The sapling/pole stage is a young stage where tree diameters (at D.B.H.) range from 1 inch to 7 inches with tree heights ranging 6-45 feet. Theses trees are 5 to 100 years of age, depending upon species and site condition.

(4) - **mature** The mature stage occurs when tree diameters reach a relatively large size (10-20+ inches) and the tree is usually 90 or more years old. Forest stands begin to experience accelerated mortality from disease and insects.

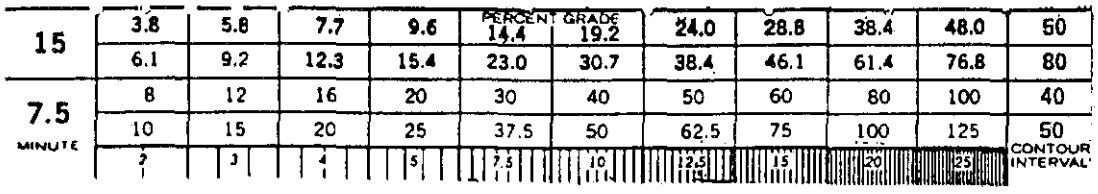
APPENDIX H (Continued)

(5) - **old-growth** The old growth stage occurs when a mature stand is advanced-age (100 years-aspen or 200 years - spruce), is very slow growing, and has advanced degrees of disease, insects, snags, and down, dead material. An exception to these occur in ponderosa pine and aspen types where theoretically, these old-growth type experience low densities of down dead material or snags.



15. Avg. Slope - Enter the average slope category code for the whole sample unit. The slope can be determined by using a Silva compass with slope gauge, clinometer, estimate, or USGS map scale on a topographic map.

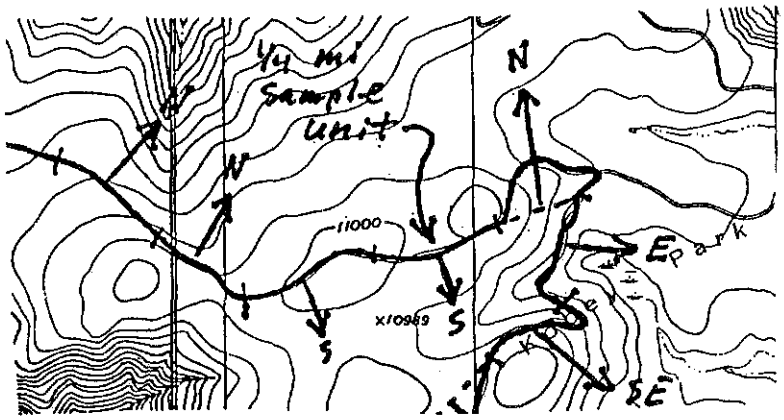
Level - 0 - 25% - L
Moderate 26-50% - M
Steep 51-75% - S
Very Steep >76% - V



USGS Slope Gauge for 7.5 and 15 minute quad maps.

APPENDIX H (Continued)

16. Avg. Aspect - Enter the average aspect for the sample unit. It may be helpful to connect the starting and ending point of the sample unit with a straight line to estimate the average aspect:



Use one of the following codes for each sample unit: N, NE, E SE, S, SW, W, NW.

17. Avg. Elev. - Estimate the average elevation for the sample unit, in most cases this should be determined as the elevation at the center of the transect sample unit.

18. Survey Vehicle Code - Enter a code for what mode of transportation was used to conduct the survey on this particular sample unit. The codes are:

snowmobile - S
cross country ski - X
snowshoe(web) - W
truck - T
ATV - A
foot - F
horse - H

19. Tracks - snowshoe hare - Record the total number of tracks that (1) cross the transect line from right to left and (2) that parallel the transect on either side but do not cross the transect. If tracks parallel the transect route but do not cross the transect, only count one set of tracks per 160 meters. Dolbeer and Clark (1975) found that the average size of a Colorado snowshoe hare home range, if it was circular in shape, would be approximately 160 meters in diameter.

20. Other Tracks - Record the total number of each type of other animal tracks that you observe on each sample unit. If the animal track is not listed as one of the choices, write it in the comments section.

21. Other/Comments - Write in the species and number of other tracks that were observed on this sample unit but are not listed as a choice on the form, i.e. beaver - 2, stripped skunk -1. Add any comments or additional notes to explain anything about the transect, i.e. south facing slope, snow melted; grass/forb structure - not suitable snowshoe habitat; snow was too powdery to determine most species; 3 unknown species; 2 positive lynx tracks!!!; etc.

SNOWSHOE HARE TRACK SURVEY FORM

Date of Survey _____ GMU's _____ County _____ Page No. ___ of ___

Starting Location General Description (distance & direction from near town or landmark, etc.) _____

Land Status Code _____ If National Forest, What Forest _____

Survey Personnel: _____

Start Location UTM Coordinates X _____ Y _____ Zone ___

End Location UTM Coordinates X _____ Y _____ Zone ___

Date & time of last snowfall _____

For Administrative Use:
Survey Route Code _____
Total Sample Units _____

Sample Unit No.		Primary Veg. Type	Secondary Veg. Type	Veg. Structure Class	Avg. Slope	Avg. Aspect	Avg. Elev.	Survey Vehicle Code	Snowshoe Hare TRACKS		OTHER TRACKS																OTHER TRACKS & COMMENTS
									Crossing	Parallel	DEER	ELK	B.H. SHEEP	MOOSE	MT GOAT	UNK CANINE	DOG	COYOTE	RED FOX	RED SQRL.	PINE MARTEN	PORCUPINE	BLUE GRSE.	BOBCAT	MT. LION	MICE OR VOLE	
1																											
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11-18-97

Example

SNOWSHOE HARE TRACK SURVEY FORM

Date of Survey 1-15-97 GMU's 45 County Eagle Page No. 1 of 2

Starting Location General Description (distance & direction from near town or landmark, etc.) 5.5 miles up The Homestake Creek RD Jct with highway 6 & 24

Land Status Code F If National Forest, What Forest White R.

Survey Personnel: B. Andree & G. Byrne

Start Location UTM Coordinates X 379100 Y 4365300 Zone 13

End Location UTM Coordinates X 374450 Y 4363300 Zone 13

Date & time of last snowfall 1-13-97 @ Noon

For Administrative Use:
Survey Route Code
Total Sample Units

Sample Unit No.	Primary Veg. Type	Secondary Veg. Type	Veg. Structure Class	Avg. Slope	Avg. Aspect	Avg. Elev.	Survey Vehicle Code	Snowshoe Hare TRACKS: Crossing	Snowshoe Hare TRACKS: Parallel	OTHER TRACKS: DEER	ELK	B.H. SHEEP	MOOSE	MT GOAT	UNK CANINE	DOG	COYOTE	RED FOX	RED SQRL.	PINE MARTEN	PORCUPINE	BLUE GRSE.	BOBCAT	MT. LION	MICE or VOLE	OTHER TRACKS & COMMENTS
1	L		4	L	SE	9100	S				2						1									
2	Z		1	L	SE	9100	S																			Unsuitable
3	L		4	L	SE	9200	S	1			4					1				2	1				2	
4	Y	L	2	L	SE	7200	S		1								1									
5	L	S	4	M	SE	9200	S				1								2	1					5	
6	L	S	4	L	S	9300	S										2		5		1				1	
7	L	S	5	L	SE	9300	S		1		1											1				
8	Z		1	L	SE	7300	S																		9	Unsuitable
9	L	S	5	M	E	7300	S																			
10	Y	Z	2	L	SE	7300	S		1		1															
11	Z		1	L	SE	9400	S																			Unsuitable
12	L	S	5	M	E	7400	S	1	1										1	1					6	
13	S	L	4	M	E	7400	S										1									
14	S	F	5	M	SE	7500	S		1																	
15	S	F	5	M	SE	7500	S												2							
16	S	F	5	M	N	9700	S		1										3	1						
17	S	F	4	M	NW	9800	S	1									1									
18	S	F	5	L	NW	10000	S		2										2	1					8	
19	L	S	4	M	SW	9400	S											1		1						
20	L		3	L	NE	9500	S																			
21	L	S	5	M	E	9600	S													1						
22	S	L	4	L	E	7700	S		1																	
23	S	F	5	L	S	9800	S								1											
24	S	F	5	M	SE	9900	S																			
25	S	F	5	M	N	9900	S		1		1								2							

11-18-97

APPENDIX H (Continued)

12/1/97 DRAFT

SNOWSHOE HARE TRACK SURVEY FORM

Example

Date of Survey 1-15-97 GMU's 45 County Eagle Page No. 2 of 2

Starting Location General Description (distance & direction from near town or landmark, etc.) _____

Land Status Code _____ If National Forest, What Forest _____

Survey Personnel: Andree & Byrne

Start Location UTM Coordinates X _____ Y _____ Zone ____

End Location UTM Coordinates X _____ Y _____ Zone ____

Date & time of last snowfall _____

For Administrative Use:
Survey Route Code _____
Total Sample Units _____

Sample Unit No.		Primary Veg. Type	Secondary Veg. Type	Veg. Structure Class	Avg. Slope	Avg. Aspect	Avg. Elev.	Survey Vehicle Code	Snowshoe Hare TRACKS		OTHER TRACKS																OTHER TRACKS & COMMENTS
									Crossing	Parallel	DEER	ELK	B.H. SHEEP	MOOSE	MT GOAT	UNK CANINE	DOG	COYOTE	RED FOX	RED SQRL.	PINE MARTEN	PORCUPINE	BLUE GRSE.	BOBCAT	MT. LION	MICE or VOLE	
1	26	S	F	5	L	NE	10,000	S	1												1		1			2	Start snowshoe transect
2	27	S	F	4	M	E	10,100	W				1									1						
3	28	S	F	5	M	SE	10,100	W										1								2	
4	29	Z		1	M	S	10,100	W																			unsuitable
5	30	Z		1	M	S	10,100	W																		4	unsuitable
6	31	S	F	5	M	SE	10,100	W	1																		walked along tree line
7	32	S	F	5	M	E	10,100	W	1																		"
8	33	S	F	5	M	SW	10,200	W		2												1					
9																											
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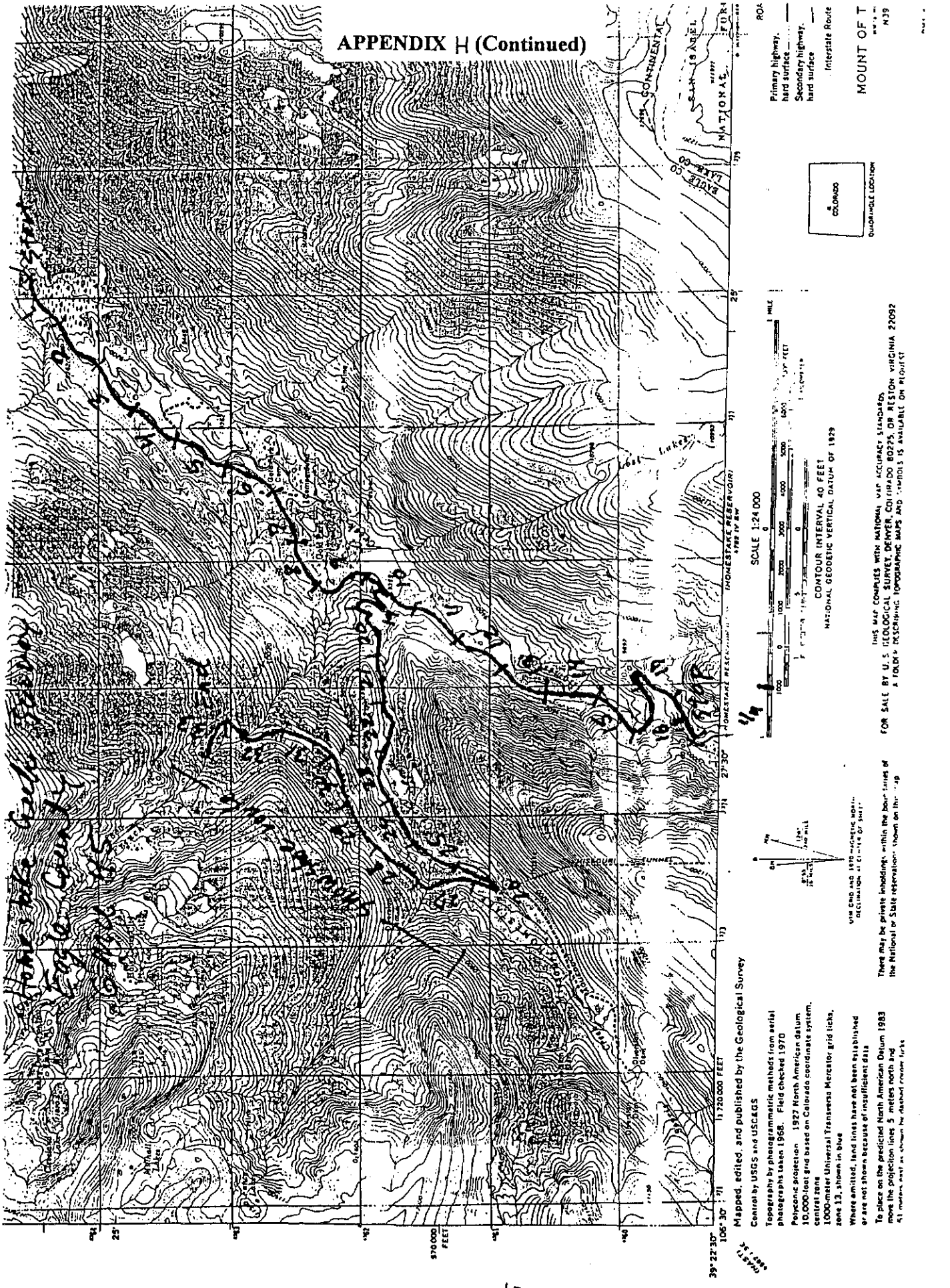
11-18-97

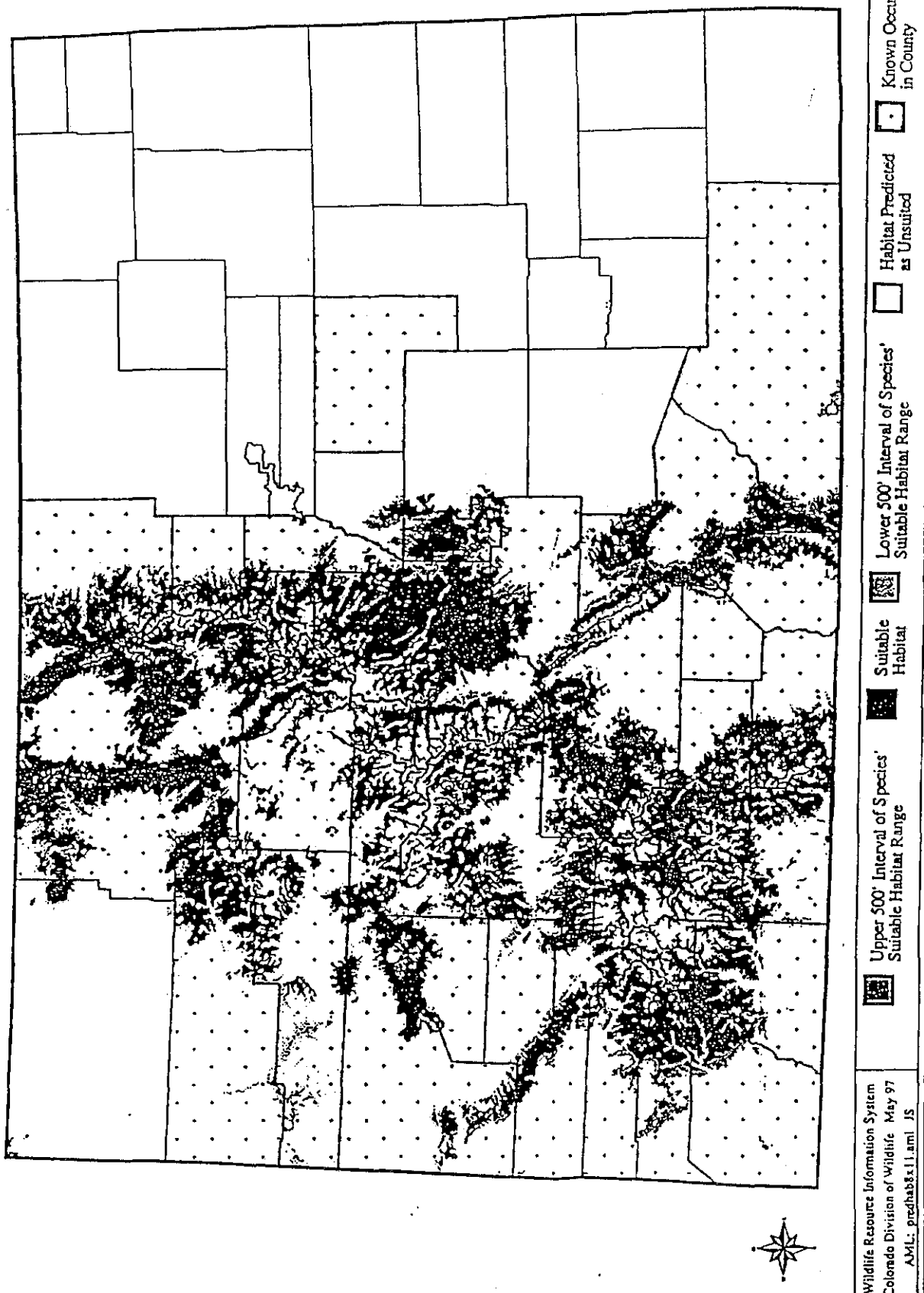
APPENDIX H (Continued)

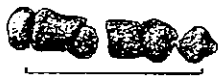
APPENDIX H (Continued)

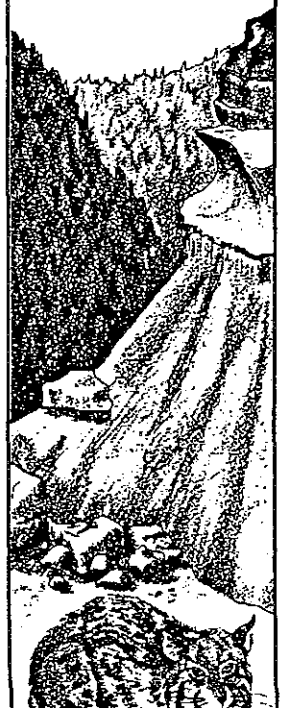


APPENDIX H (Continued)

Potential Distribution Model:
X50111: Snowshoe Hare (L. a. bairdii) (Lepus americanus)



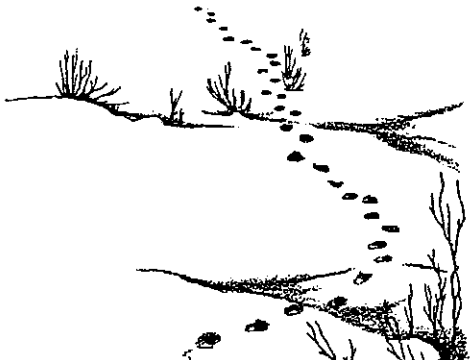




BOBCAT
Felis rufus

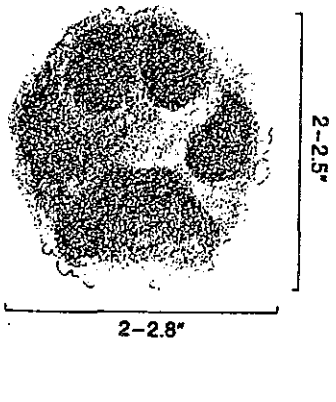
Description: Bobcats have gray, buff, or reddish fur dappled with black spots, long legs, and a bob tail. Total length ranges from 26 to 50 inches with the tail 4 to 8 inches. Bobcats weigh 15 to 35 pounds.

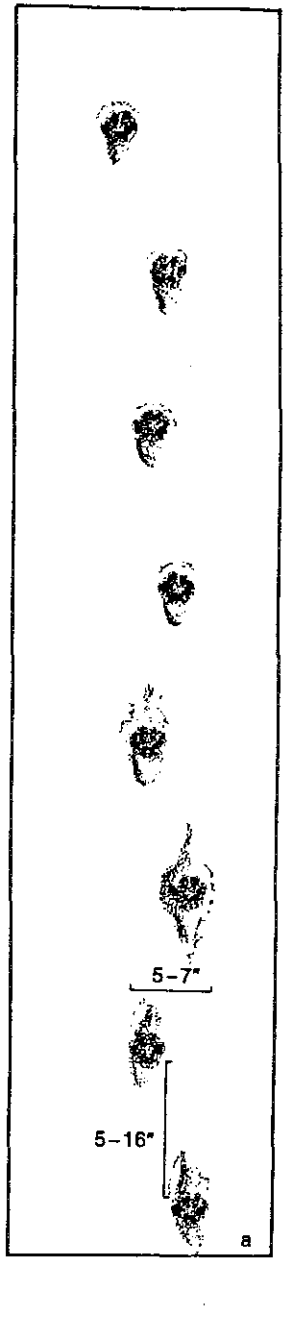
Habits: Bobcats live in broken, semi-open and rocky areas in deserts and forests where they find shelter in rock crevices, under trees and stumps, and in logs and thickets. They feed on a variety of rodents, rabbits, and other small animals. They are active year-round, solitary, and primarily nocturnal. Bobcat populations have thrived with the habitat changes associated with humans, while lynx populations have declined.

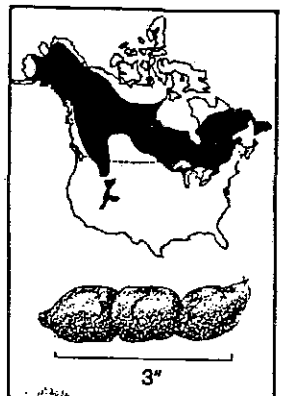


Track Pattern: Like other felids, bobcats walk in an alternating track pattern (*a*), making prints about twice the size of a housecat's. They infrequently gallop in a four-print pattern. Their tracks, much smaller than lynx tracks, could be confused with coyote or fox tracks, but they have distinctive cat features—claws are rarely visible, prints are as wide or wider than long, and foot drag marks are rare. Like lynx, the hind legs sink in deep snow, making a "handle" at the back of the print. The toe pads are often visible; in firm, wet snow, the double-lobed front of the heel pad is evident. Bobcat trails meander rather than run directly.

Associated Signs: Along a bobcat trail, you may find urination scent-posts marking a territory and scats similar to those of lynx and coyotes. Bobcats tend to cover their scats, like housecats, leaving scratch marks in the snow.



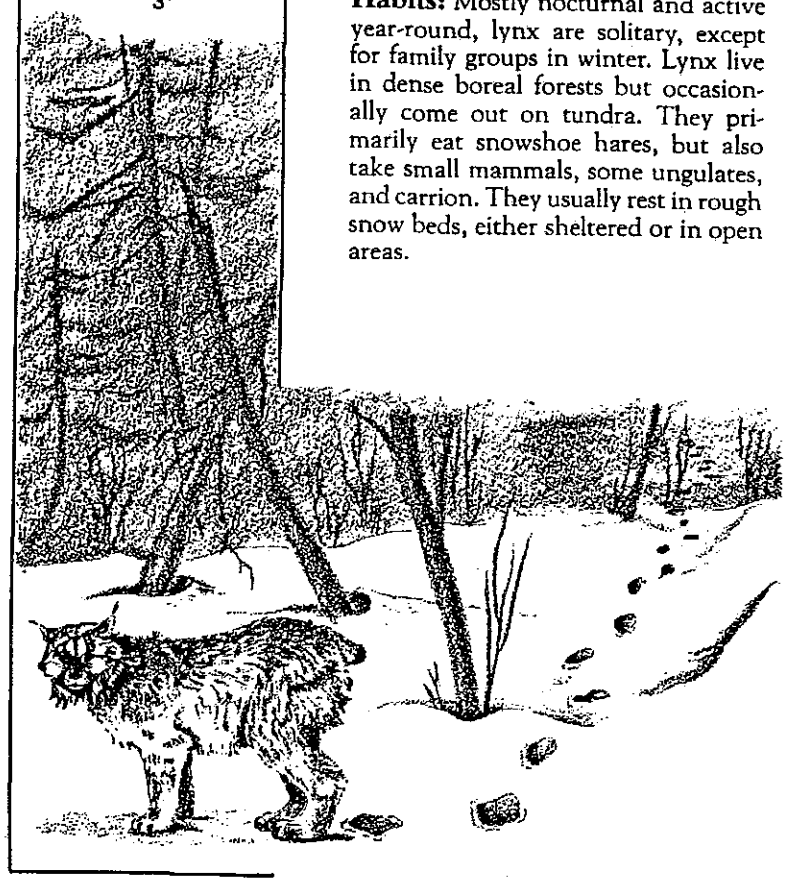




LYNX
Felis lynx

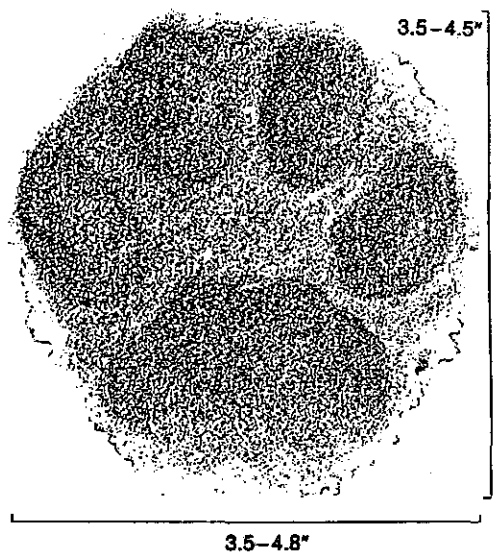
Description: Lynx have mottled tawny, brown, black and white fur, long ear tufts, long legs, and a bob tail. Their feet, remarkably large and heavily furred below, aid in snow travel. Total length is 33 to 38 inches with the tail 4 to 5 inches. Weight is 15 to 30 pounds.

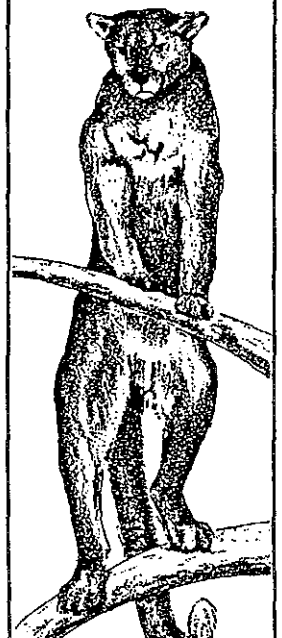
Habits: Mostly nocturnal and active year-round, lynx are solitary, except for family groups in winter. Lynx live in dense boreal forests but occasionally come out on tundra. They primarily eat snowshoe hares, but also take small mammals, some ungulates, and carrion. They usually rest in rough snow beds, either sheltered or in open areas.



Track Pattern: Lynx usually walk in an alternating pattern (*a*) and infrequently gallop in a four-print pattern. They place their feet "lightly" and deliberately, rarely dragging their feet or bodies. In deep snow, the hind legs sink, making a rear "handle" on the print. Lynx trails meander through the forest, unlike coyote or wolf trails, and may cross forest openings. The track pattern and print size are similar to those of the mountain lion; however, the straddle is generally smaller, foot pads are usually obscured by hair, and tracks sink no deeper than about 8 inches in the snow.

Associated Signs: Lynx leave frequent urination scent-posts marking their territories and scats similar to those of coyotes. They sometimes attempt to cover these and their kills. Resting beds appear as troughs in snow, deepening with use.





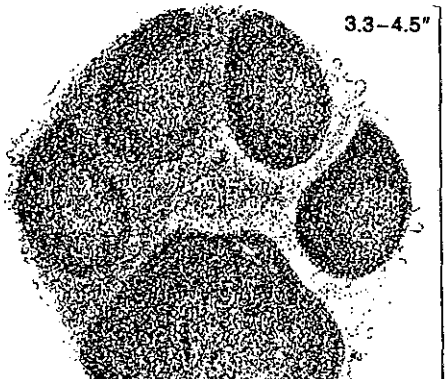
MOUNTAIN LION
Felis concolor

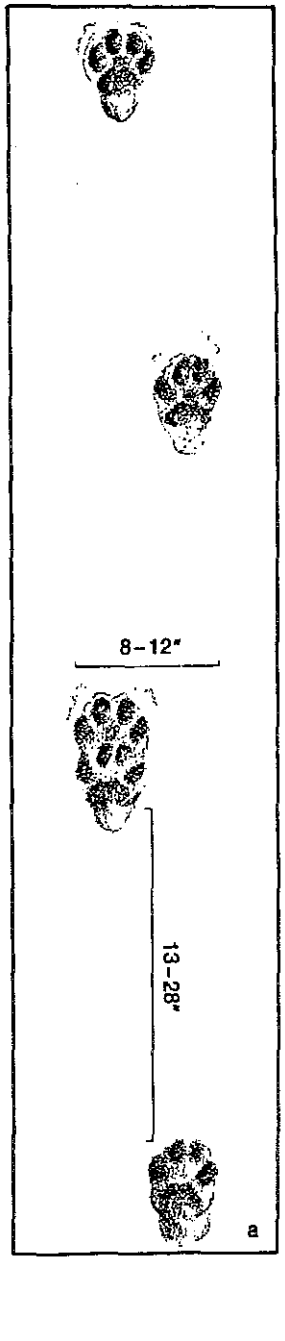
Description: Mountain lions, also called pumas or cougars, are the largest North American cats. Colored gray to tawny, they have long legs and a long dark-tipped tail. Total length is 60 to 110 inches with the tail 21 to 31 inches. Weight is 80 to 200 pounds.

Habits: Mountain lions live in mountain forests and semiwooded areas from sea level to 10,000 feet wherever deer, their primary food, are abundant. They also eat small mammals, other ungulates, carrion, and livestock. They are mostly nocturnal, solitary, and active year-round, denning in rock shelters, caves, thickets, overhanging banks or hollow stumps.

Track Pattern: Mountain lions usually walk, making an alternating track pattern in snow (*a*). Sometimes, the hind feet do not quite register on the front-foot prints in shallow snow. Infrequently, they gallop in a four-print pattern after prey. The heavy cougar's foot pads often register in snow, and their bellies drag in deep snow. Their round prints sometimes show lobes at the front (2) and back (3) of the heel pad on firm snow, but rarely show claws. Prints are as wide or wider than long. Their tails may leave marks at sitting spots. Trails are mostly straight and may lead to trees, which they climb.

Associated Signs: A cougar trail may lead you to a preferred, secluded spot where a kill was dragged and partially buried under snow or debris (also a bear habit in spring). Cougar scats usually contain fur and bone parts and resemble those of large dogs. Places where cougars have scented and urinated to mark their territories are found along trails.





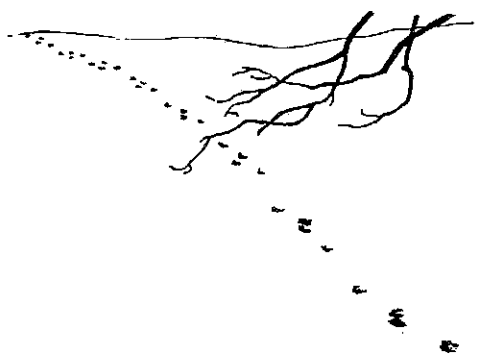
STRIPED SKUNK

Mephitis mephitis

Description: Striped skunks have short legs and stout, black bodies with two white stripes extending along their sides from head to tail. Bushy tails are carried high. Total length is 20 to 32 inches with the tail 7 to 16 inches. Weight is 6 to 14 pounds.

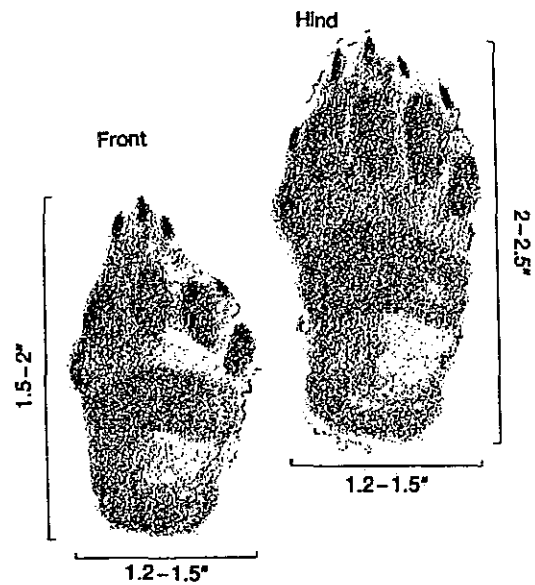
Habits: Striped skunks are widely distributed but prefer marshes, farmland, and riparian growth along streams in dry country. They do not generally occur at higher elevations in mountain regions. These skunks are more active at night than day; eat various small animals, plants, carrion and garbage; and den in usurped rodent burrows or under wood piles, cutbanks, stumps, or buildings.

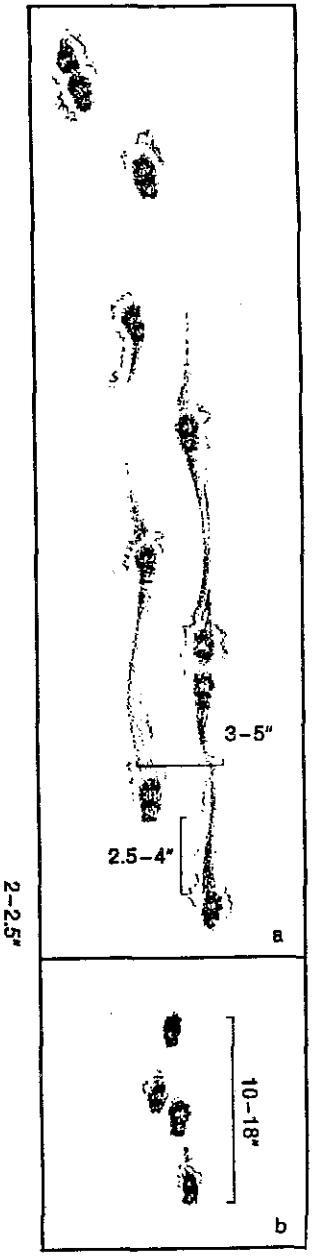
Track Pattern: Striped skunks den up in cold weather, sometimes in small groups. When venturing outside, they vary their gait from a walk or trot in



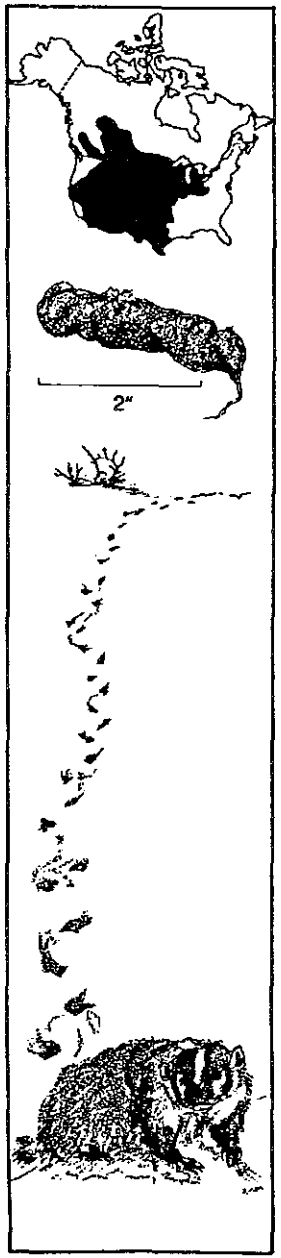
a sometimes erratic alternating track pattern (*a*) to a clumsy lope in a four-print pattern (*b*), common in shallow snow. When loping, striped skunks make short leaps so that each four-print group falls close to the next, making it difficult to delineate one group from another. In deeper snow, skunks walk, their straddle widens, and their bodies drag. Foot dragging is common at most snow depths, and the long claws on the front feet often register.

Associated Signs: Skunks have developed the mustelid family scent glands into a fine and odiferous weapon. Often, the odor lingers in places that skunks have recently visited. Other striped skunk signs include digging spots and cylindrical, chunky scats, which are uncommon.





APPENDIX H (Continued)



BADGER
Taxidea taxus

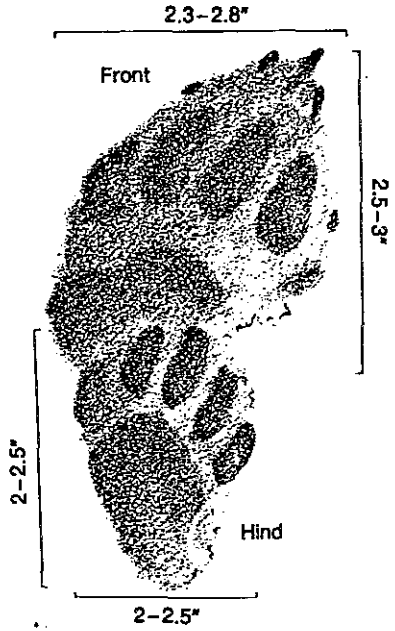
Description: Built like small tanks with strong, short forelegs and clawed forefeet highly suited for digging, badgers are yellowish-gray with white-tipped guard hairs and white facial marks. Total length is 21 to 35 inches with a short tail 4 to 6 inches. Badgers weigh 13 to 25 pounds.

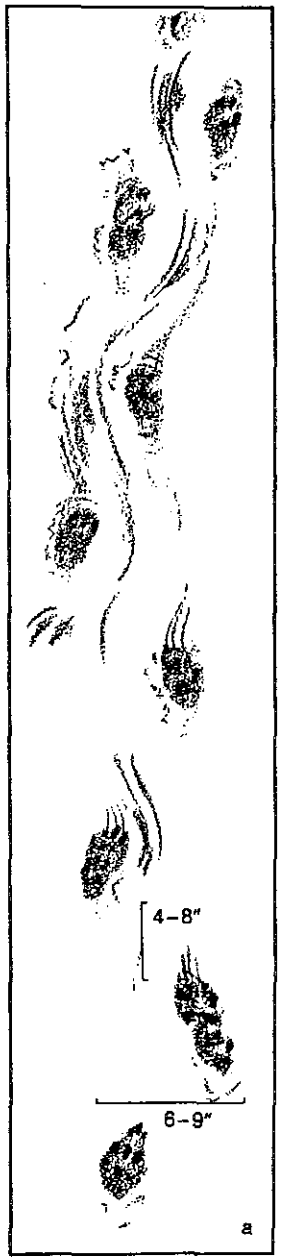
Habits: Badgers live in shrublands and grasslands as well as in the semi-open forests near them—wherever there are abundant ground squirrels, prairie dogs, pocket gophers, and other small animals to eat. Mainly nocturnal and solitary, badgers live in burrows they dig themselves or expand from rodent burrows.

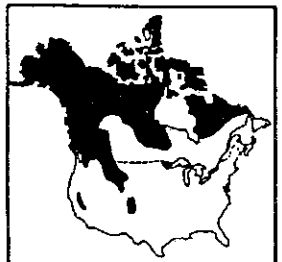
Track Pattern: Unlike most other mustelids, badgers may den for several weeks or months in midwinter, depending on the severity of the winter.

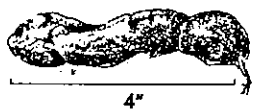
Thus, their tracks are found in snow mostly in fall or spring. When badgers emerge onto snow, they walk, plodding in a pigeon-toed alternating track pattern (*a*) similar to that of the porcupine. However, badger trails lack the brushlike drag marks of quills, take longer steps, and are closely associated with burrows and diggings. A badger's long front-foot claws often register in snow.

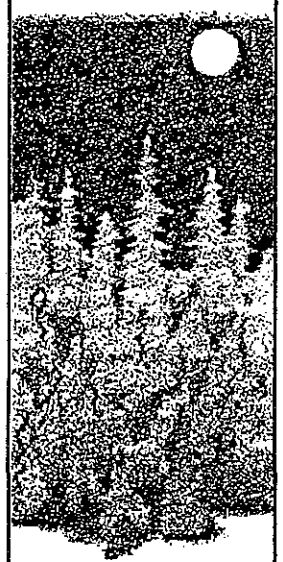
Associated Signs: Badgers leave a large disorderly dirt pile when they dig out burrows hunting for rodents or making dens. Their burrow entrances are about 6 to 12 inches wide—the bane of many a horseback rider. Large rocks and dirt clods are also excavated, and fox- to coyote-sized scats and urinations are sometimes found nearby.











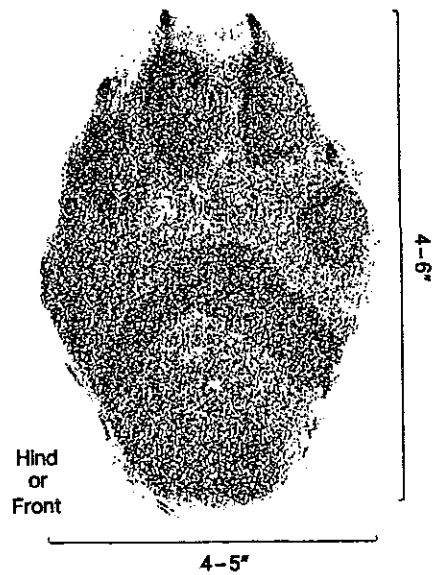
WOLVERINE
Gulo gulo

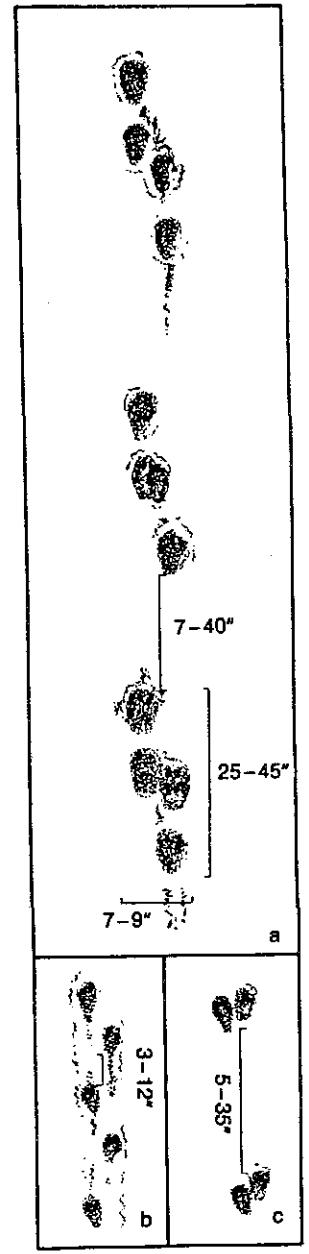
Description: The wolverine, the largest mustelid, is dark brown with broad, light stripes along its sides from head to tail. It has a stocky, almost bearlike body with relatively large feet and short legs. Total length is 32 to 45 inches with a tail 7 to 10 inches. Weight is 18 to 45 pounds.

Habits: Wolverines live in coniferous mountain forests and arctic and alpine tundra, now mostly in wilder, more remote areas. Solitary and active at any time year-round, wolverines are primarily scavengers, but also eat various small to medium-sized animals and sometimes ungulates—any of which they may cache for winter. They rest in the lee of rocks, trees, or slopes and may den under fallen trees, in rock crevices, or in snow.

Track Pattern: This strong, hefty weasel has a variety of erratic gaits and nearly wolf-size tracks that usually show claw and foot drag marks. In light or firm snow, wolverines commonly lope in a three- or four-print pattern (*a*). They may also walk in an alternating track pattern (*b*) or resort to the mustelid two-print lope (*c*), usually in soft, deep snow. Even though their prints are similar in size to those of wolves, lynx and cougars, the wolverines' erratic gaits are diagnostic. Wolverines are wide-ranging and may cover many miles as they hunt for prey or search for carcasses to feed on.

Associated Signs: Wolverines leave urinations and large, weasel-like scats to mark their territories along trails. A wolverine's damage to traplines and cabins is legendary, but often overrated.





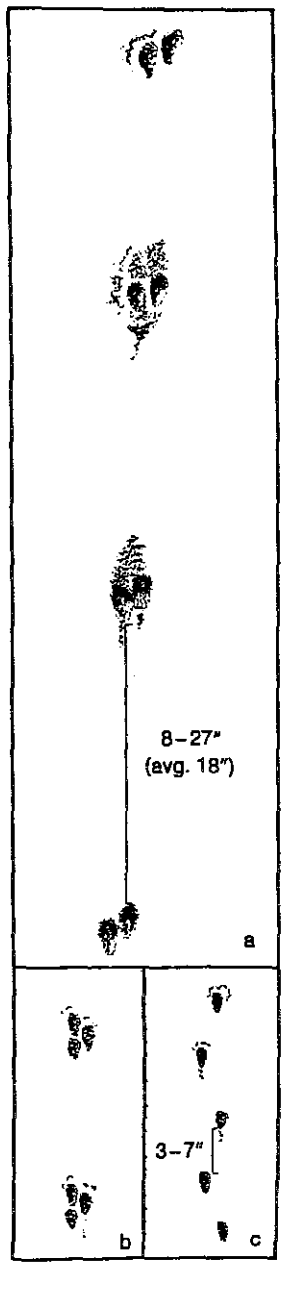
MINK
Mustela vison

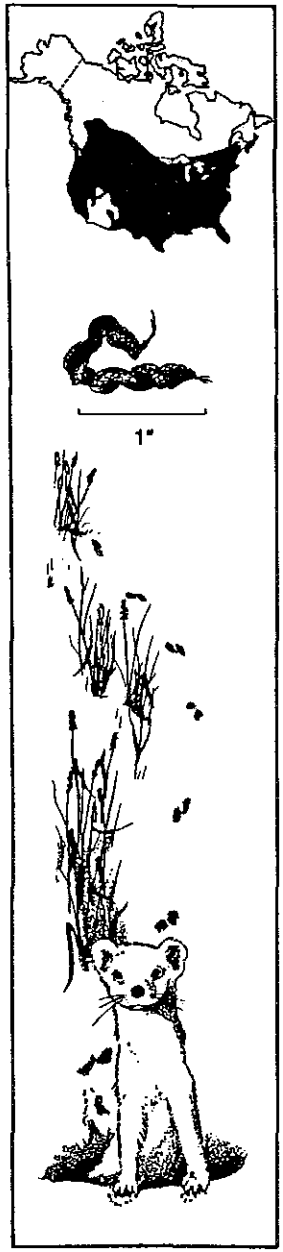
Description: This medium-sized dark-brown mustelid is shaped like other small weasels, long and thin with short legs. Total length is 18 to 29 inches with the tail 6 to 8 inches. Mink weigh 1.3 to 3 pounds.

Habits: Solitary, nocturnal, and active year-round, mink are semiaquatic and live near marshes, streams, rivers, lakes, ponds, forest edges, and tidal flats at a variety of elevations. They den near water under tree roots, piles of brush or logs or in muskrat or beaver dens in banks. They eat a variety of small animals, such as small mammals, fish, reptiles, amphibians, and birds.

Track Pattern: Mink lope making an angled mustelid two-print track pattern (*a*), which may show three prints at times (*b*). They may also slow to a walk in an alternating pattern (*c*). In soft, deep snow, their feet, body, and tail may drag. Soles are not heavily furred in winter. Mink trails usually run along shores of waterways and often lead into the water.

Associated Signs: Like otters, mink seem to have a fun-loving nature and often slide through the snow into water, down embankments, or along level snow (often after exiting the water). These slide marks, 4–5 inches wide, are distinctly smaller than those of river otters (as are their tracks) but often occur in the same areas. Look for urinations and scats along mink trails. Scats are dark and weasel-shaped but often contain fish parts, fur, or feathers.





LONG-TAILED WEASEL

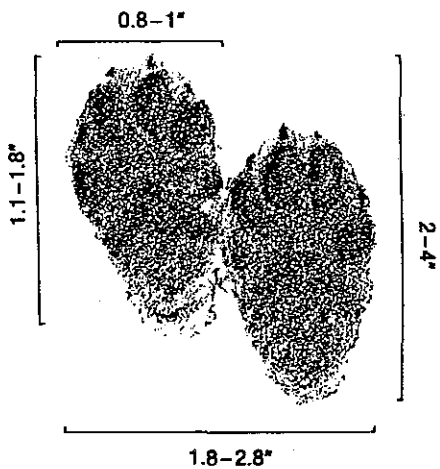
Mustela frenata

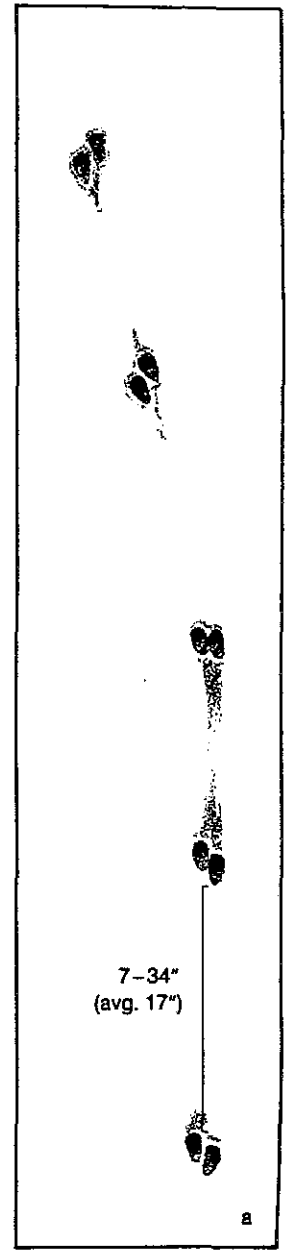
Description: Like other small weasels in northern areas, long-tailed weasels turn white in winter, except for a black-tipped tail. Total length is 12 to 22 inches with a tail 5 to 10 inches. They weigh 3 to 12 ounces.

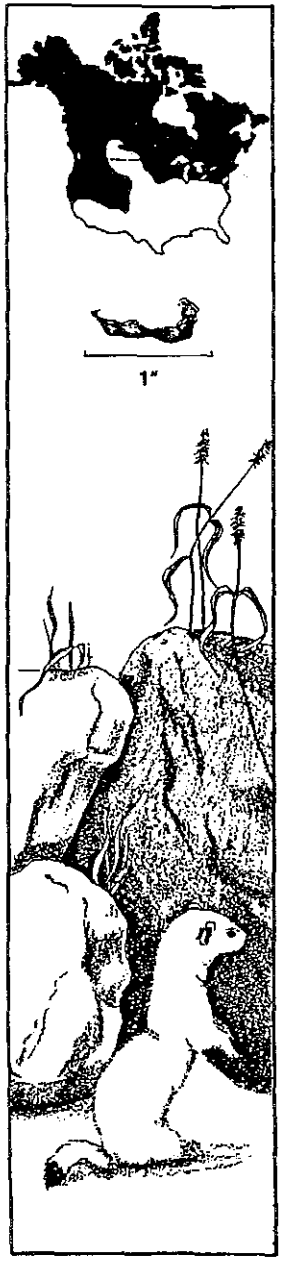
Habits: Long-tailed weasels occupy a wide variety of habitats from sea level to alpine areas, including open grasslands, river bottoms, aspen parklands, woodlands, and alpine tundra. They prefer drier uplands of grass, forest, and rock and feed primarily on small mammals, especially voles and mice, which are sometimes cached in winter. They are solitary, mostly nocturnal, and active year-round.

Track Pattern: Long-tailed weasels make a typical mustelid two-print lope with their feet often at a slight angle to direction of travel (*a*). In soft snow, their bodies sometimes drag between alternate bounds. These weasels make straight or zigzag trails, and they dive under the snow to hunt for prey. Their tracks may overlap in size with those of large male ermines and small female mink and ferrets. But long-tailed weasels do not make the distinctly alternating long and short leaps of ermines, range farther from water than mink, and do not make large, diagnostic ferret diggings.

Associated Signs: Along long-tailed weasel trails, you may find scats, urinations, and burrow openings into the snow (about 3 inches wide). Occasionally, these weasels dig small piles of dirt out of rodent burrows.





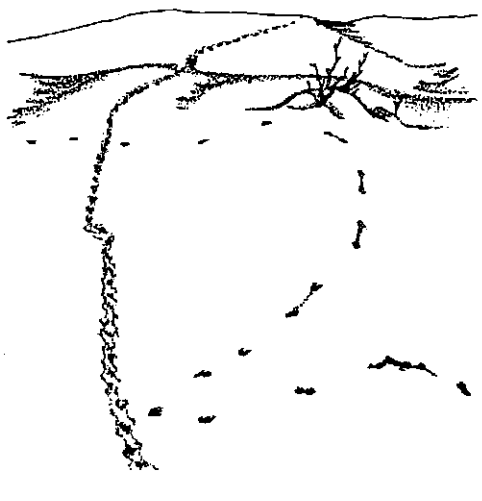


SHORT-TAILED WEASEL

Mustela erminea

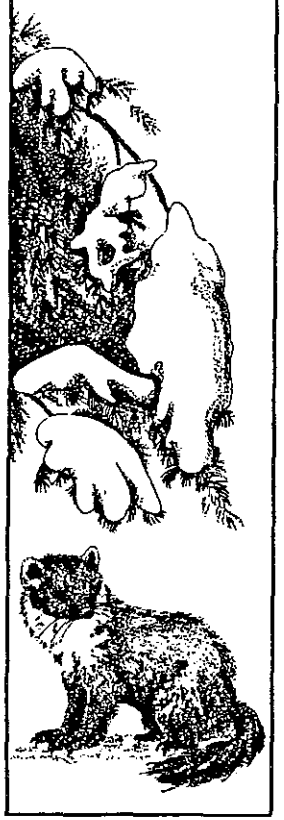
Description: Also called ermines, short-tailed weasels are small weasels that turn white in winter except for the black tip of their tail. Total length is 8 to 14 inches with the tail 2 to 3 inches. Weight is 1 to 6 ounces.

Habits: Short-tailed weasels live in a variety of habitats, such as open meadows, stream bottoms, rock slides, tundra, and near forests—from sea level to 10,000 feet. They are more confined to mountains than the larger long-tailed weasels. Nocturnal and solitary, they feed on small mammals, especially mice and voles, which they cache in winter dens in logs, under roots or in burrows of small rodents.



Track Pattern: Loping in a small, angled, two-print track pattern the size of fingertips touching snow, short-tailed weasels often alternate long and short leaps (*a*). Their bodies drag a trough between the short leaps in soft snow. Like other small weasels, their winter-furred feet rarely show distinct pads or claws. The energy and curiosity of this small carnivore is expressed in a trail that can cover meadows with wild zigzags, circles, double-backs, and short tunnels through the snow—the diligent hunting record of one ermine. Ermines often hunt under the snow.

Associated Signs: Look for tunnels in snow (about 2 inches wide) where ermines have hunted small rodents, and for rare urinations or scats along their trails. You may also see an odd trail with extra drag marks alongside. That's the trail of an ermine carrying prey in its mouth (see illustration).



AMERICAN MARTEN

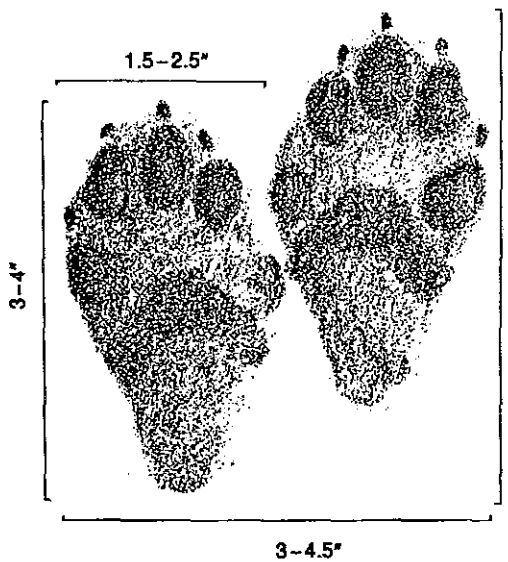
Martes americana

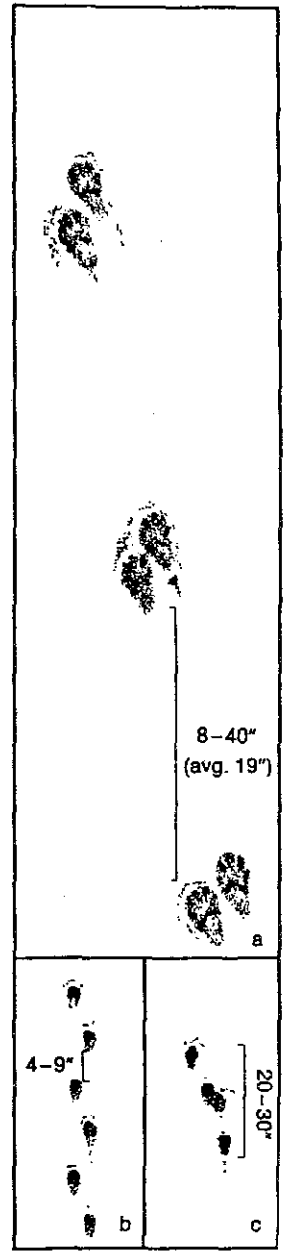
Description: This medium-sized mustelid has brown to rufous fur with a yellow to orange throat patch, short legs, and soles that are thickly furred in winter. Total length is 20 to 27 inches with the tail 6.5 to 9.5 inches. Weight is 1.5 to 2.8 pounds.

Habits: Primarily nocturnal and solitary, martens are restricted to conifer forests where they den in trees, tree cavities, or under the snow. They feed mainly on small rodents. Their range has been reduced in the U.S. and Canada due to overtrapping and habitat loss, although some reintroductions have been successful.

Track Pattern: Martens lope in an angled two-print track pattern (*a*). Their tracks may show claw marks and are large relative to other mustelids of similar body size. At times, martens slow to a walk (*b*) or speed up to a gallop (*c*). Their trails run through forests, across clearings, down holes in the snow, or to trees, which they readily climb. Martens often visit the subnivean world, resting in warm cavities under rocks, stumps, or logs, or hunting in the maze of runways and nests used by squirrels and small rodents. Tracks of male martens and female fishers may overlap in size.

Associated Signs: Tracks are often the only marten sign found in snow. Look for a rare scat or urination, or for sitzmarks with a tail print—a place where a marten landed after it jumped from a tree.





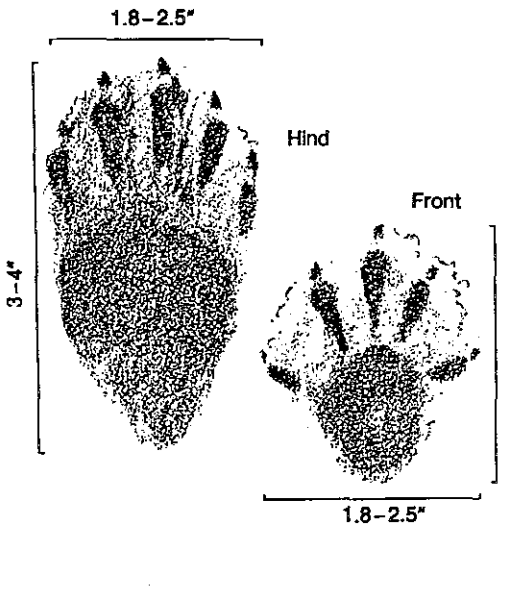
RACCOON
Procyon lotor

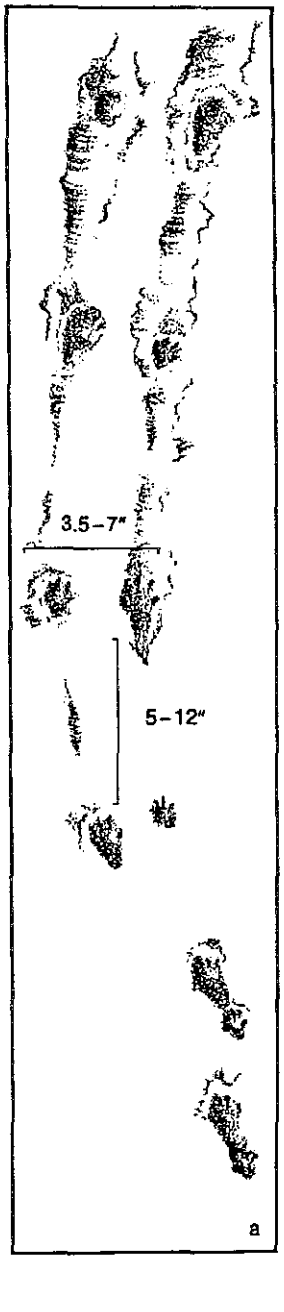
Description: Masked and dark gray with a black-and-brown-striped bushy tail, raccoons have chunky bodies and relatively short legs with agile, long-toed feet. Total length is 24 to 38 inches with the tail 8 to 16 inches. Weight is 12 to 35 pounds.

Habits: Raccoons prefer brushy or wooded areas at lower elevations near water where they den in hollow trees, stumps, small caves, culverts, or abandoned burrows. Primarily nocturnal, they live alone or in small groups and feed on a variety of plant and animal material. They do not hesitate to visit garbage containers in suburban areas.

Track Pattern: In snow country, raccoons build up fat reserves and stay inactive in their dens from November–December to February–April to avoid both the cold weather and snow cover. In mild spells (around 20 °F) or in spring, they venture onto the snow, typically walking in an uncommon two-print pattern in which the hind feet fall next to the front-foot prints of the opposite side (*upper a*). At times, tracks in deep snow break into an alternating track pattern for short periods (*lower a*). Raccoons do not drag their tails in snow, although the long toes and claws often register. Their straddle increases in deep snow.

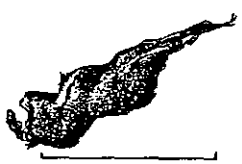
Associated Signs: Other raccoon signs are rare and include granular, black to brown scats of an irregularly cylindrical shape and omnivorous content. Of course, if a raccoon has raided your cabin or garbage, the mess is all too evident.





Arctic Fox

Red Fox



2"

LARGE-FOOTED FOXES

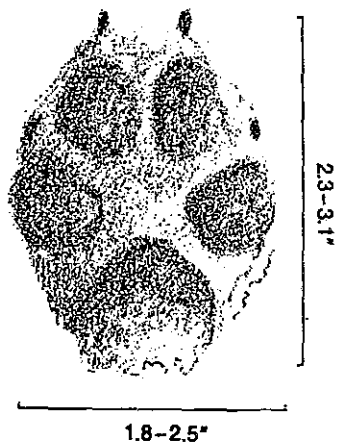
Alopex and *Vulpes* species

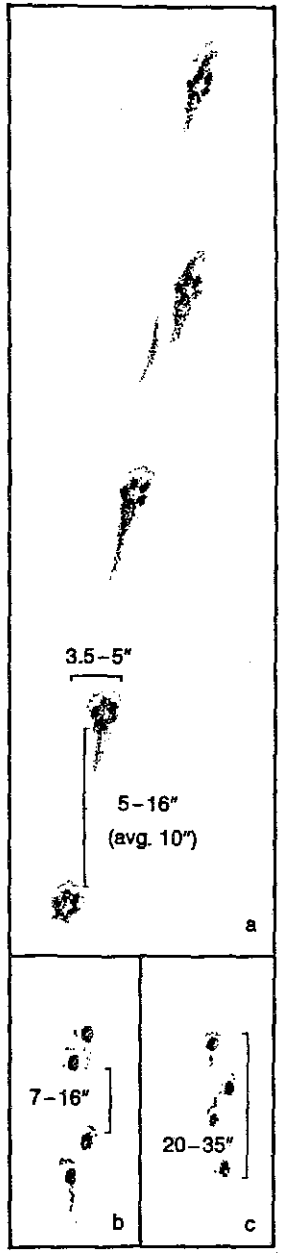
Description: Arctic foxes (*Alopex lagopus*) are white or "blue" in winter with thickly haired feet, while red foxes (*Vulpes vulpes*) do not change colors but have dark color phases. Both are the size of small domestic dogs with long legs and slim bodies. Total length is 32 to 45 inches with a bushy tail 11 to 17 inches. Weight is 7 to 15 pounds.

Habits: Arctic foxes live in arctic and alpine tundra and boreal forests, often trailing wolves and polar bears in winter to feed off their kills. They also catch lemmings and other small animals. Red foxes use various habitats including farmland but prefer semiopen areas in foothills and mountains. They eat small animals and carrion. Both are mainly nocturnal, largely solitary, and active all year.

Track Pattern: These foxes walk or trot in an alternating pattern (*a*) with their prints nearly in a line. In shallow snow, they may trot in a two-print pattern (*b*) or gallop in four-print patterns (see c and Key on inside front cover). Their dainty, oval tracks usually show foot pads, front claws, and foot drag marks. On firm snow, a transverse bar across the heel pad of the red fox may obscure the print of the pad. More wary travelers than wolves or coyotes, foxes tend to travel closer to cover. Arctic fox tracks are the larger of the two.

Associated Signs: Foxes urinate at scent markers and leave small doglike scats containing bone fragments or hair of prey. Look for spots where foxes have hunted small rodents by digging into the snow. Perhaps they left some blood and fur if they were lucky.





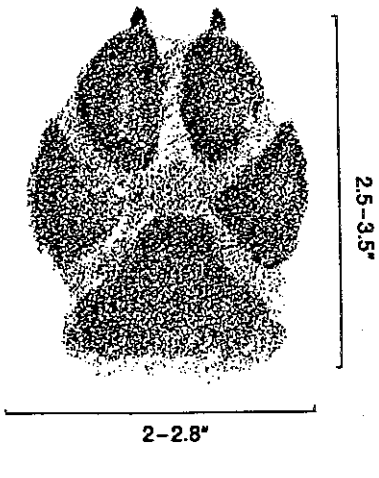
COYOTE
Canis latrans

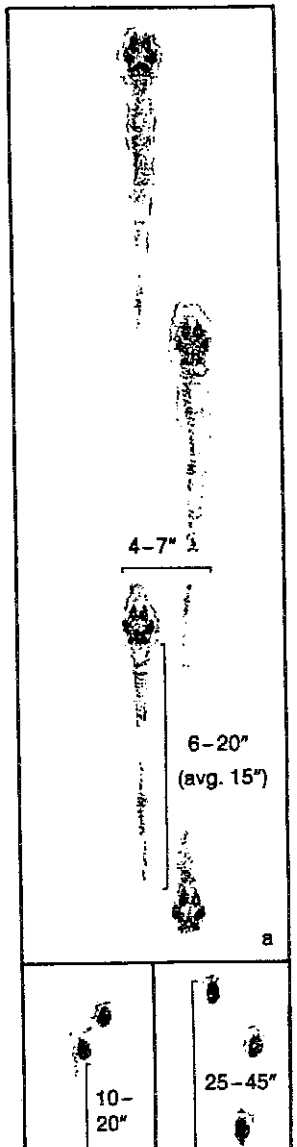
Description: About the size of a small collie, coyotes are gray-brown, often washed with lighter colors, and have long legs and tails. Total length is 42 to 53 inches with a bushy tail 12 to 16 inches. Adults weigh 20 to 50 pounds.

Habits: Still expanding their range across North America, coyotes typically live in areas of open prairie and desert, but are also found from forested mountains to alpine regions as well as in suburban areas. Primarily nocturnal, social at times, and active year-round, they feed on small mammals, carrion, various plants, insects and young of ungulates and livestock.

Track Pattern: Coyotes typically walk and trot in an alternating track pattern (*a*). The walking gait has shorter intergroup lengths and a wider straddle than the trot, and is used in deep snow. Less common gaits include a two-print trot (*b*) and a lope or gallop in one of the four-print gallop patterns (see *c* and Key on inside front cover). Coyotes drag their feet in soft or deep snow and their bodies in snow deeper than about 1 foot. Their oval tracks usually show foot pads and claw marks from at least the front two toes. Coyote trails may meander but are often bold, straight-line routes made by one or more individuals.

Associated Signs: A coyote trail often reveals a bounty of activities—a mouse chase, a roll in the snow, a meeting with other coyotes, scent-marks with urine or scats (doglike, often composed of hair or bone pieces), or a resting bed in the snow. Sometimes during the day you'll hear the "song dog's" riotous yips nearby.

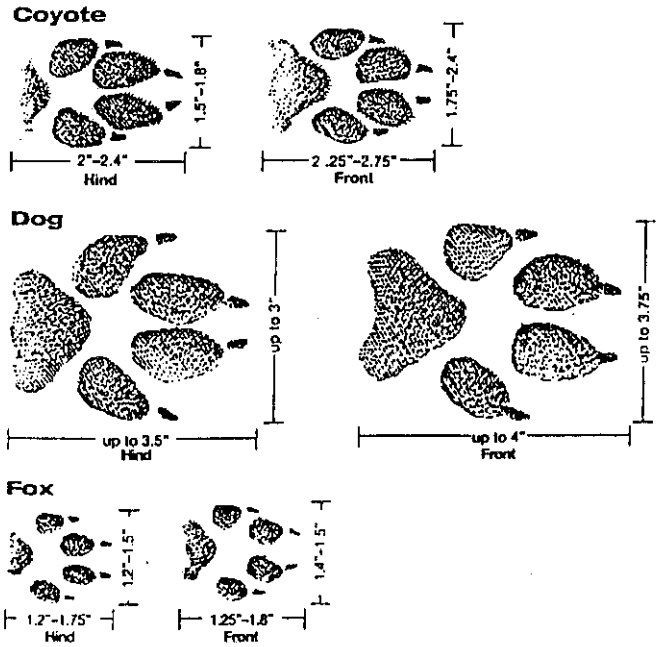




APPENDIX H (Continued)

Coyote

Historically, coyotes have been maligned for raiding livestock and preying on game animals. But coyotes, unlike wolves, cougars, and even grizzlies, have prospered despite an all-out war that ranchers, farmers, and the government have waged on these predators. This month, OUTDOOR LIFE takes a close look at one of this continent's most adaptive, cunning, and controversial creatures.

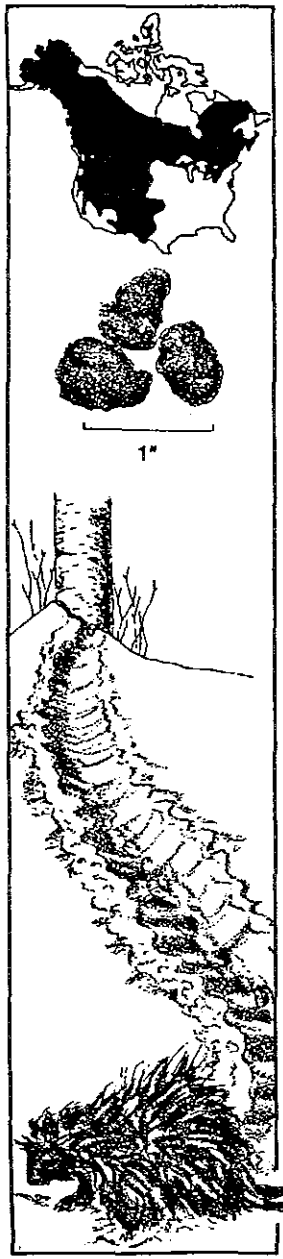


Coyote, Dog, or Fox?

Differences in the tracks of canids are subtle yet distinct. Coyote tracks are smaller, more elongated (with longer lateral toes), and have less distinct heel pad impressions than those of a dog of approximately equal size. Fox tracks, meanwhile, are smaller still, and their straddle (the track width) never exceeds 3 ½ inches, compared to the average 4- to 6-inch straddle of both dog and coyote trails. Note: Print sizes are adult averages.

The Rabbit Ruse

There's no better time to hunt coyotes than midwinter, when their pelt is prime, tracks are obvious, and, with food scattered (or underground), they are particularly responsive to the sounds of an easy meal. Tips: In cottontail country, deliver the distress call in high-pitched staccato bursts, but where jackrabbits or snowshoe hares predominate, go for low, raspy squeals. If you don't have a commercial call, improvise: Press your top teeth against your bottom lip (or vice versa) and suck air in short pulls. On calm, quiet winter days, the resultant squeaks can reach across vast distances to a coyote, whose audio system is specially tuned to pick up high-register sounds of alarm.



PORCUPINE
Erethizon dorsatum

Description: Another well-known and widely distributed rodent, porcupines have dark fur interspersed with conspicuous long, stiff guard hairs or quills. They have short legs and wide, stocky bodies. Total length is 26 to 41 inches with the tail 6 to 12 inches. Weight is 10 to 28 pounds.

Habits: Porcupines prefer conifer forests, but they also live in a variety of other habitats, including tundra, desert, and mixed and deciduous forests—wherever they can find vegetation to eat. Their winter food is the cambium, phloem, and foliage of woody shrubs, saplings, and trees. Porcupines are solitary, nocturnal, and active year-around.

Track Pattern: Porcupines plod through the snow making a pigeon-toed alternating track pattern (*a*). It is similar to a badger's but has shorter intergroup lengths, quill drag marks and leads to trees rather than burrows. The hind foot overlaps the front foot in shallow snow. In soft snow, the porcupine's body plows a trough marked with foot dragging and the side-to-side swishing of stiff tail quills. Its trails run between dens and trees or brush, readily climbed for feeding.

Associated Signs: Look for porcupine gnawings resembling shallow beaver gnawings but high up in the trees. Scats are found by the bases of trees or at a porcupine's winter den—a cave or culvert or under a log or roots. A fresh trail usually means that Porky is nearby, resting in a den or tree or swaying uncertainly in a willow. Take a look around.

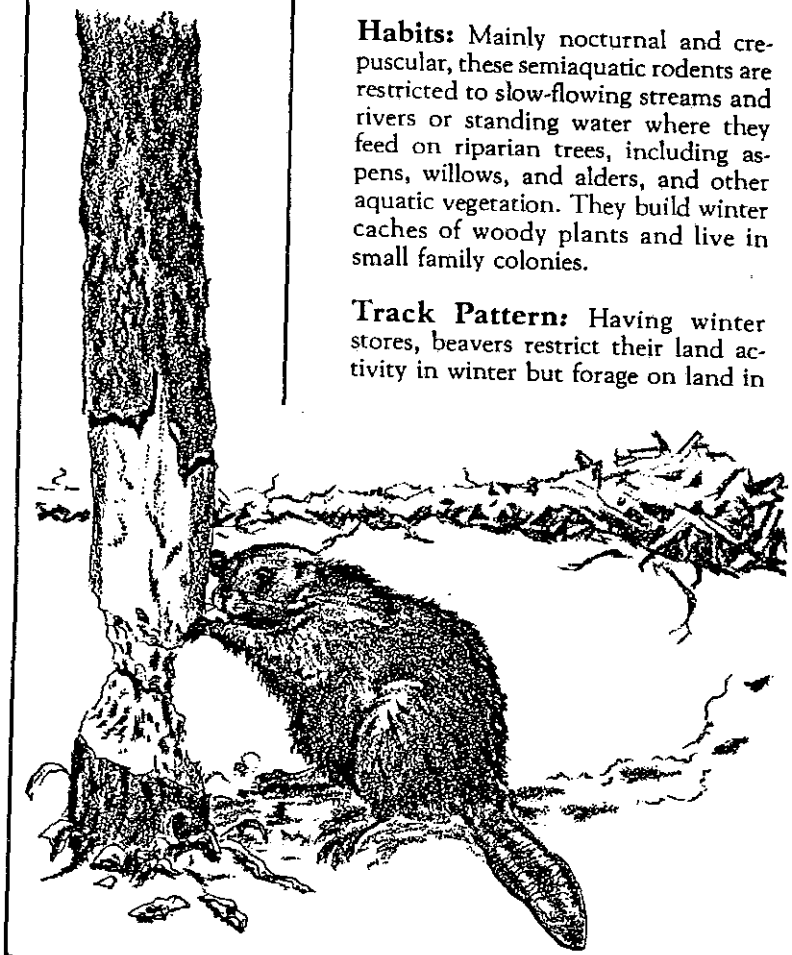
BEAVER

Castor canadensis

Description: Beavers, the largest North American rodents, are dark-brown with long, flat, scaly tails; short legs; and large, webbed hind feet. Total length averages 39 inches, the tail 18 inches. Weight is 30 to 60 pounds.

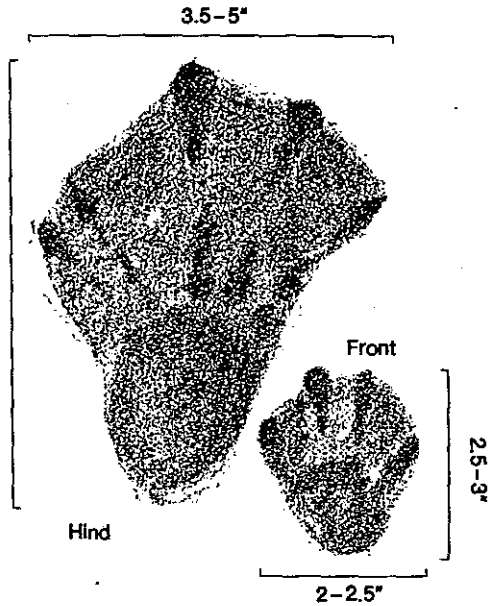
Habits: Mainly nocturnal and crepuscular, these semiaquatic rodents are restricted to slow-flowing streams and rivers or standing water where they feed on riparian trees, including aspens, willows, and alders, and other aquatic vegetation. They build winter caches of woody plants and live in small family colonies.

Track Pattern: Having winter stores, beavers restrict their land activity in winter but forage on land in

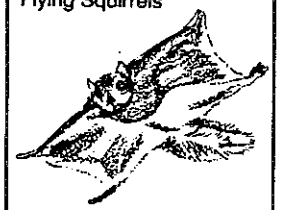


fall and spring. They walk in an alternating track pattern (*a*), which often shows large, webbed hind feet (and three or more long toes), and wide, snaking tail and body drag marks. Vegetation being carried may also drag. The hind feet may fall beside the front feet on hard snow (*lower a*).

Associated Signs: Beaver signs include dams of gnawed wood, domed lodges of wood and mud, beaver ponds behind dams, and gnawed trees and limbs on land nearby. Beavers stand on the ground to gnaw on trees, leaving broad teeth marks penetrating deep into the heartwood. (*Note*: "Ground" can be the top of a 4-foot-deep snowpack!) They are similar to but deeper and lower down on trees than porcupine gnawings. Scats are not deposited on land.



Flying Squirrels



Red and Douglas' Squirrels

SMALL TREE SQUIRRELS

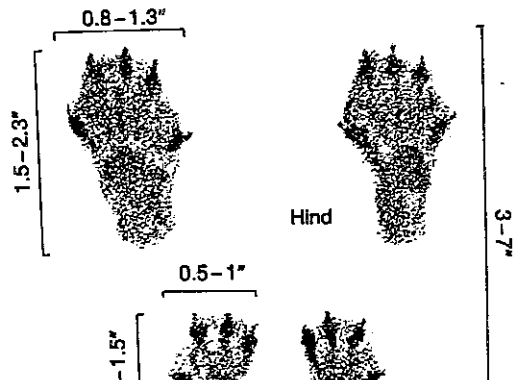
Tamiasciurus and *Glaucomys* species

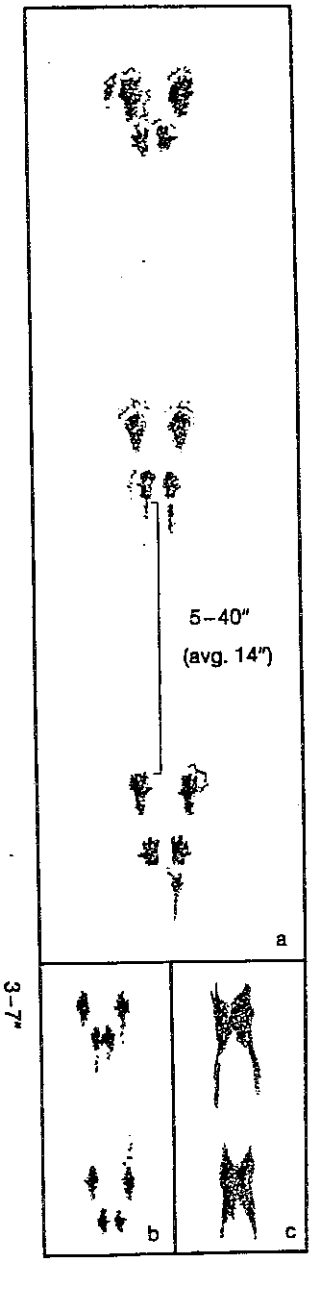
Description: This arboreal group includes red squirrels (*Tamiasciurus hudsonicus*, colored red-brown); Douglas' squirrels or chickarees (*T. douglasii*, dark-brown); and flying squirrels (*Glaucomys* species, brown or gray and white) with prominent fur-covered membranes along their sides. Total length is 9 to 15 inches; tail is 3 to 7 inches; weight is 2 to 9 ounces.

Habits: Red squirrels live in conifer or mixed forests, Douglas' squirrels in dense conifer forests, and flying squirrels in deciduous and conifer forests. The diurnal and solitary *Tamiasciurus* species store large conifer seed caches on the ground for winter, while the more social, nocturnal flying squirrels may store nuts and seeds in tree holes.

Track Pattern: Squirrels in this group hop making a squarish four-print track pattern with their front feet landing side by side (*a*). Front prints may merge (*b*). In deeper snow, hind and front prints merge into a two-print pattern showing foot drag marks (*c*). Flying squirrels seldom glide to the ground, but when they land, they may make a sitzmark showing their outstretched winglike membranes. Trails run between trees. All these squirrels den up in stormy weather, but only flying squirrels become torpid for short periods.

Associated Signs: *Tamiasciurus* species scold intruders with loud chattering. They tunnel through snow to nests and food caches near which may be found piles of castoff cone scales and cores (middens) and some scats. They also make leafy tree nests. Flying squirrels leave few signs, maybe a few gnawed nuts below their tree cavity nests.





JACKRABBITS AND OTHER HARES

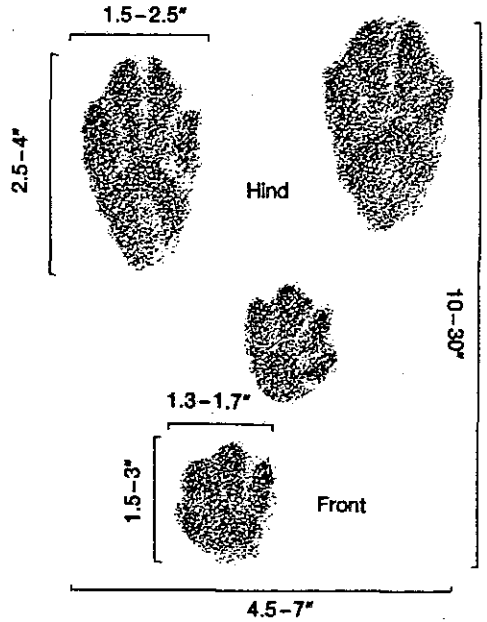
Lepus species

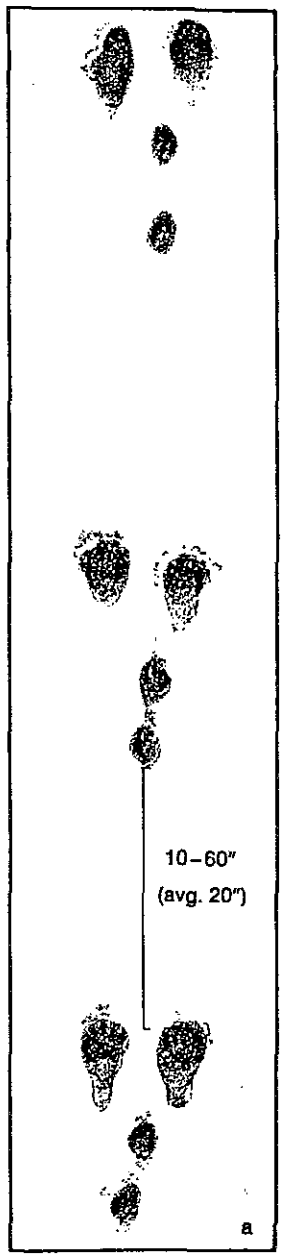
Description: This group includes arctic (*Lepus arcticus*) and Alaska (*L. othus*) hares and white-tailed jackrabbits (*L. townsendii*), which turn white in winter, as well as black-tailed jackrabbits (*L. californicus*) and European hares (*L. capensis*), which lighten but never turn white. All have long hind legs and large hind feet. Total length ranges from 19 to 27 inches with the tail 1.5 to 4.5 inches. Weight is 3 to 12 pounds.

Habits: White-tailed jackrabbits prefer open foothills, grasslands, and shrublands. Black-tails prefer drier areas but are spreading into white-tail habitat. Arctic and Alaska hares live in open arctic tundra, and European hares inhabit open hills and open hardwood forests. All eat woody plant parts in winter, are mainly nocturnal and crepuscular, and are active during the winter.

Track Pattern: These hares make a four-print jumping track pattern (*a*) similar to that of snowshoe hares, except that the hind feet are smaller. Also, the track group of the speedy jackrabbits (with leaps to 10 feet!) is often more extended. When the hind legs sink into deep snow, they create a 2-inch or larger extension to the hind-foot prints. Oddly enough, arctic hares may hop briefly on two hind feet when alarmed. Black-tailed jackrabbit tracks, the smallest of this group, are at the lowest size range shown.

Associated Signs: Signs of hares include round, brown, fibrous pellets left near feeding and resting sites, neatly clipped twigs 1 to 2 feet from the ground, and resting forms in snow. On prairies, watch for the flattened ears and back of a jackrabbit hiding in the shelter of an old badger burrow.





SNOWSHOE HARE

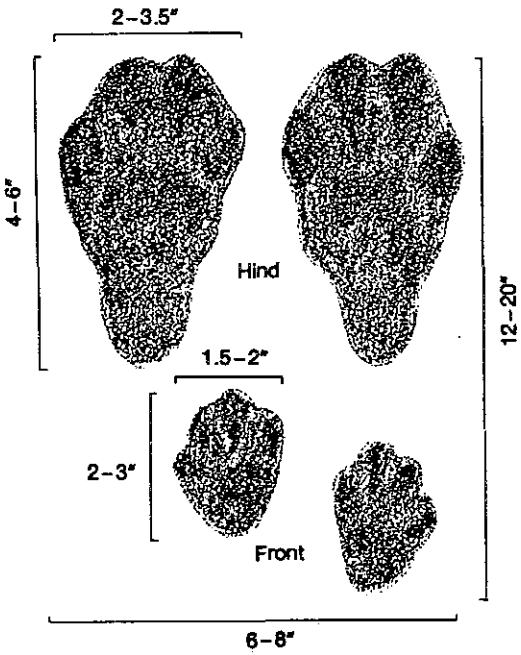
Lepus americanus

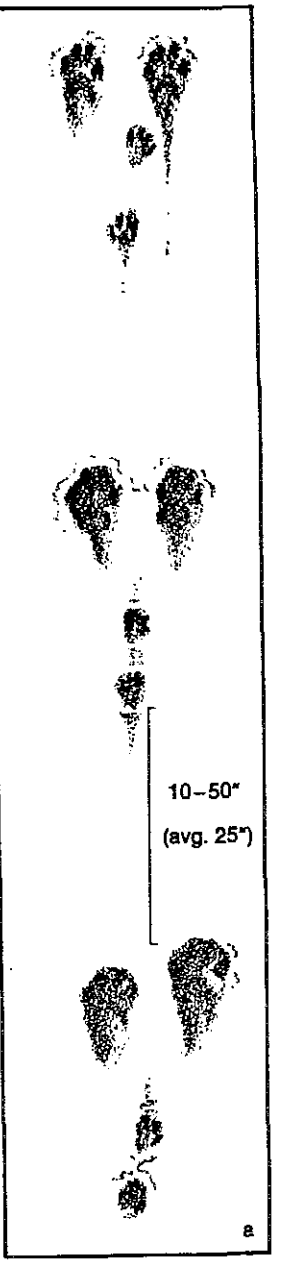
Description: In winter, snowshoe hares, or varying hares, grow particularly thick fur on the soles of their hind feet, making "snowshoes" well-suited to snow travel. Pelage turns white in winter except for black-tipped ears. Total length is 15 to 21 inches, tail is 1 to 2 inches, and weight is 2 to 4 pounds.

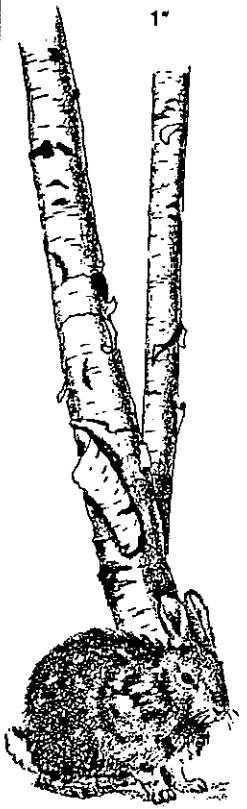
Habits: Snowshoe hares live in brushy thickets in coniferous or mixed hardwood-conifer forests where they rest in forms under the cover of downed or standing trees and shrubs. Winter foods include twigs, bark, buds, and leaves of evergreen saplings or shrubs. These hares are active all winter, mainly nocturnal and crepuscular, and more gregarious than other hares.

Track Pattern: Snowshoe hares jump making the four-print track pattern typical of rabbits, except that the hind feet are nearly twice the size of the front feet (*a*). When snow is soft and deep, these hares often pack trails and runways through the brush. Because this hare's four-print group may extend up to 40 inches at top speed, you may only see the two hind or front prints at first. Make sure to stand back and look for the entire track group.

Associated Signs: Round, fibrous, light-brown pellets are often found near resting or feeding sites. Snowshoe hares clip twigs or buds at a neat 45° angle 1 to 2 feet off the ground. Following their tracks, you are likely to find a resting form in the brush nearby—or a brief glimpse of the hare you just scared away!





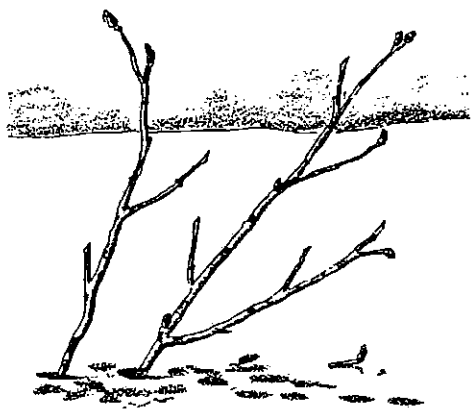


COTTONTAIL RABBITS

Other *Sylvilagus* species

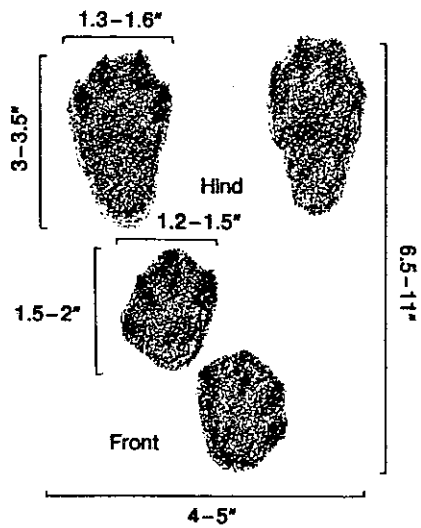
Description: These gray to brown medium-sized rabbits have partially or totally white "cotton puff" tails, large hind feet, and long hind legs. Total length varies by species from 12 to 18 inches with the tail 1 to 3 inches long. Weight is 1.3 to 4 pounds.

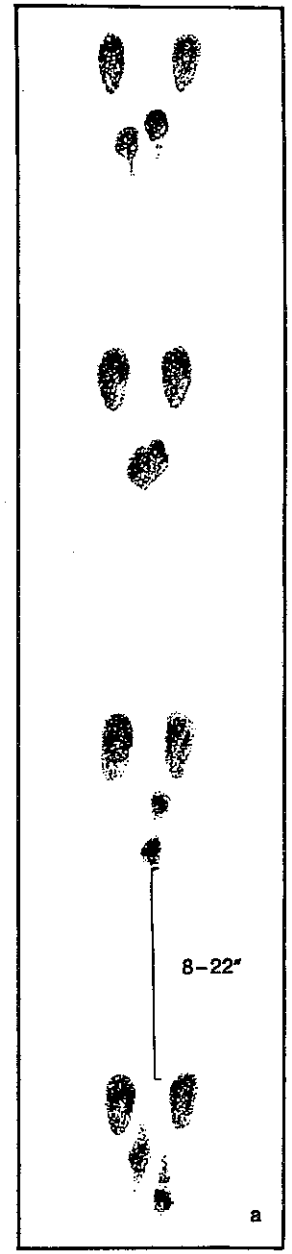
Habits: In eastern North America, cottontails live in heavy brush areas or dense boreal forests, while in the west they are found in brushy areas, as well as in open, dry shrublands and grasslands. Winter foods include bark, twigs, and woody vegetation. Cottontails are active all winter, except during severe weather, and are somewhat solitary, nocturnal, and crepuscular.



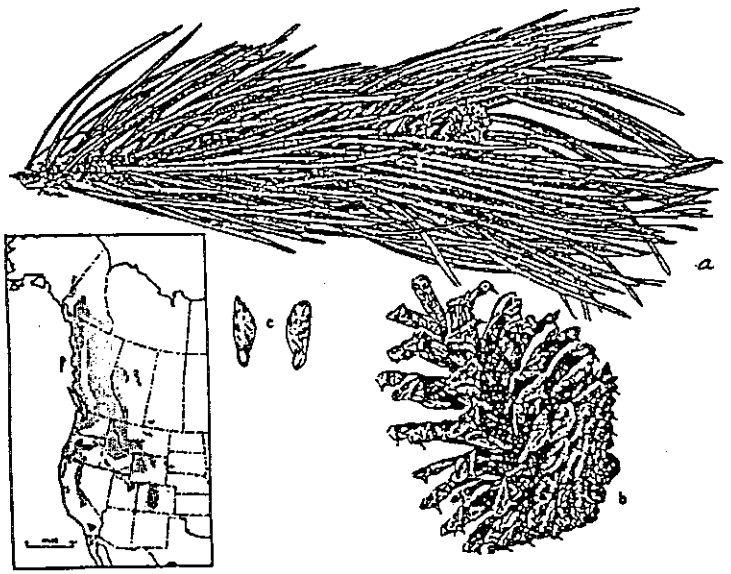
Track Pattern: Like other lagomorphs, cottontails jump making a four-print track pattern, their larger hind feet landing ahead of their front feet (*a*). Sometimes the front-foot prints merge with each other or with the hind-foot prints to make a three-print track group. The hind legs may sink into soft, deep snow, creating about an inch-long handle on the hind-foot prints.

Associated Signs: Cottontails typically leave round, fibrous pellets at resting and feeding sites, and they neatly clip buds and twigs within a foot or two of the ground. Their winter nests are usually depression-like forms concealed in brush or grass or in abandoned burrows of other animals. It is not uncommon to have one explode from under your feet when you pass by its hidden resting site.





LODGEPOLE PINE



(a) Foliage, x 3/5; (b) Mature cone, x 3/5; (c) Seed, x 2/3.

PINACEAE

LODGEPOLE PINE

Pinus contorta Dougl.

HABIT. A tree 70–80 feet high and 1¼–2½ feet in diameter (max. 150 by 3 feet); long, slender bole; short crown.

LEAVES. In fascicles of 2; 1–3 inches long; stout; often twisted; bright yellow-green; persistent 4–6 years; margins with minute teeth; basal sheath persistent.

FLOWERS. Orange-red; male in spikes; female clustered.

FRUIT. Subsessile; ¾–2 inches long; ovoid; frequently remaining closed and on the tree for many years; scales at base knoblike, armed with long prickle. Seed: ⅛ inch long; thin, dark red-brown shell; wings ½ inch long.

TWIGS. Stout; light orange-brown, becoming black. Winter buds: ¼ inch long, ovoid, dark chestnut-brown, resinous.

BARK. Very thin, rarely over ⅜ inch thick; orange-brown to gray; covered by thin, loosely appressed scales.

WOOD. Moderately important; soft; fine-textured; sapwood thick; heartwood pale brown; tangential surface with many indentations; used for lumber, ties, poles, and mine timbers.

SILVICAL CHARACTERS. Intolerant; growth slow; maturity reached in about 200 years; shallow root system; reproduction vigorous, typically forming dense stands following fires; fire, bark beetles, and mistletoe cause damage.

HABITAT. Canadian zone; altitudinal range from 6,000–11,000 feet; adapted to variety of soil types; in pure, dense, even-aged stands, or in mixture with various conifers.

GENERAL. Some authors distinguish two varieties: Shore Pine, *P. contorta* var. *contorta*, a stunted, short-leaved, twisted cone tree of the Pacific Coast; and Lodgepole Pine, *P. contorta* var. *latifolia* Engelm., the taller inland tree described above.

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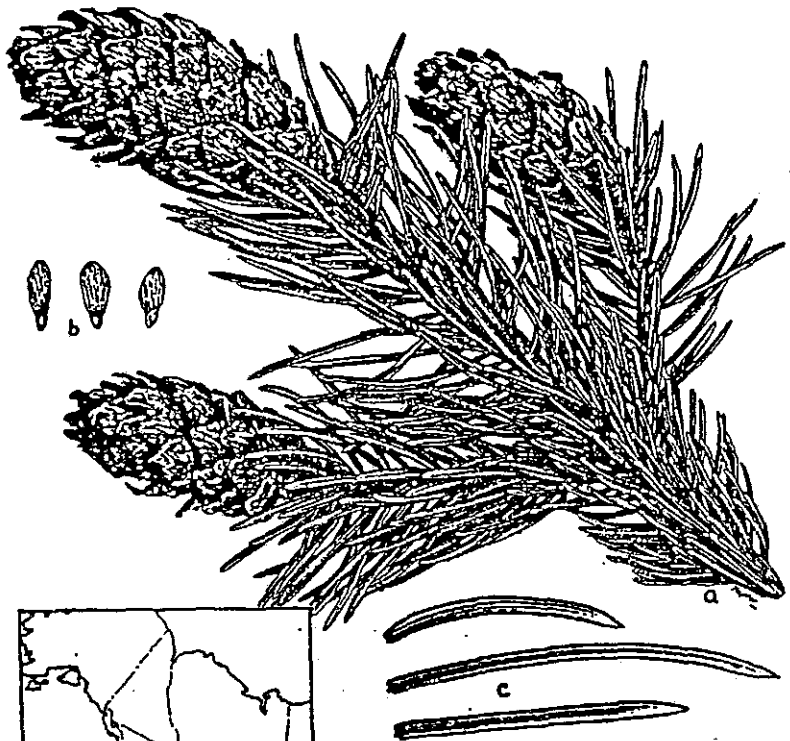
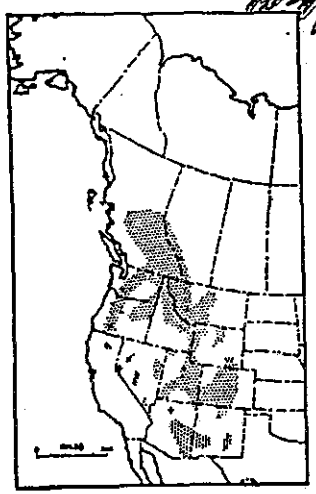




a. Branchlet with cones, x 1.

b. Seed, x 1.

c. Enlarged needles, x 2.

PINACEAE

ENGELMANN SPRUCE

Picea engelmannii Parry

HABIT. A tree 60–120 feet high and 1½–3 feet in diameter (max. 165 by 5 feet); bole long but limby, cylindrical; crown compact, somewhat scraggly, narrowly pyramidal, with short, whorled branches. A prostrate shrub at high elevations.

LEAVES. Tending to be crowded on the upper side of the branch by the curving of those on the lower side; 1–1⅛ inches long; 4-angled; blue-green, occasionally with whitish, glaucous bloom; blunt or acute tips (not very sharp to touch); flexible; no resin ducts in cross section.

FLOWERS. Male dark purple; female bright scarlet.

FRUIT. 1–2½ inches long; oblong-cylindrical; sessile or short-stalked; cone scales flexible, variable in outline and erose-dentate at apex; light chestnut-brown; falling during autumn or winter of first season. Seed: ⅛ inch long, nearly black; broad, oblique wing ½ inch long.

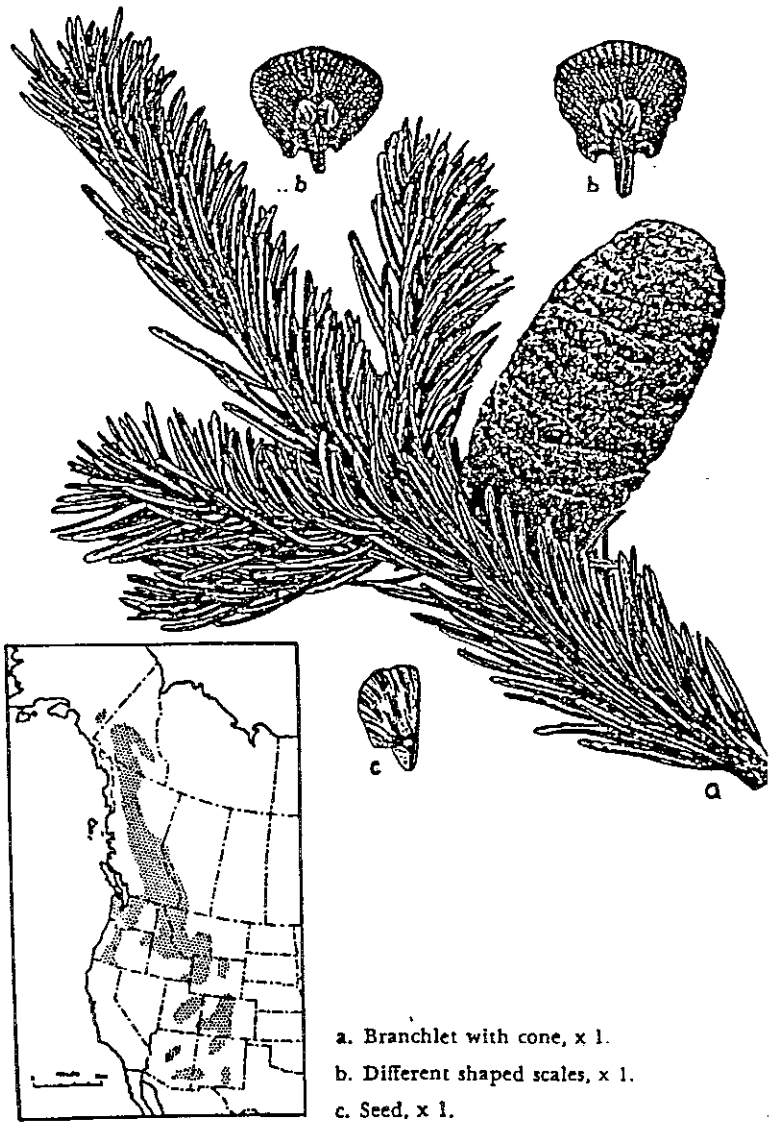
TWIGS. Minutely pubescent (visible with hand lens); rather stout; orange-brown to gray-brown. Winter buds: ⅛–¼ inch long; broadly ovoid to conic; pale chestnut-brown; but scales usually appressed.

BARK. Thin, ¼–½ inch thick; cinnamon-red to purple-brown; broken into large, thin, loosely attached scales.

WOOD. Properties similar to white spruce; this is the longest-fibered and lightest weight spruce, but at present not widely used because inaccessible; lumber, telephone poles, railroad ties, mine timbers, and fuel.

SILVICAL CHARACTERS. Tolerant and recovering well from prolonged suppression; growth generally rather slow because of short summer season; a long-lived tree, reaching ages of 350–500 or more years; reproduction abundant and vigorous; shallow, spreading root system.

HABITAT. Hudsonian and Canadian zones; varying from 1,500–5,000 feet in the northern Rockies to 10,000–12,000 feet in the southern Rockies; rich, loamy soils with abundance of moisture; in pure stands or in mixture with alpine fir, lodgepole pine, and other conifers growing at high elevations.



a. Branchlet with cone, x 1.

b. Different shaped scales, x 1.

c. Seed, x 1.

SUBALPINE FIR

Abies lasiocarpa (Hook.) Nutt.

HABIT. A tree 60–100 feet high and 1½–2 feet in diameter (max. 160 by 3 feet); a dense, narrowly pyramidal, spirelike crown often extending to the ground, with short, thick branches; a prostrate shrub at timber line.

LEAVES. On lower branches, 1–1¾ inches long (mostly about 1 inch), flattened, blunt or notched; on upper branches ½ inch long and pointed; deep blue-green; crowded and nearly erect by a twist at their base; stomatiferous on both surfaces (less conspicuous above).

FLOWERS. Male dark indigo-blue; female dark purple.

FRUIT. 2–4 inches long, oblong-cylindric, dark purple; scales mostly longer than broad and 3 times longer than long-tipped bracts. Seed: ¼ inch long, with dark lustrous wings.

TWIGS. Stout, pubescent, and pale orange-brown; becoming smooth and gray or silver-white. Winter buds: subglobose, resinous, ⅛–¼ inch long, with light orange-brown scales.

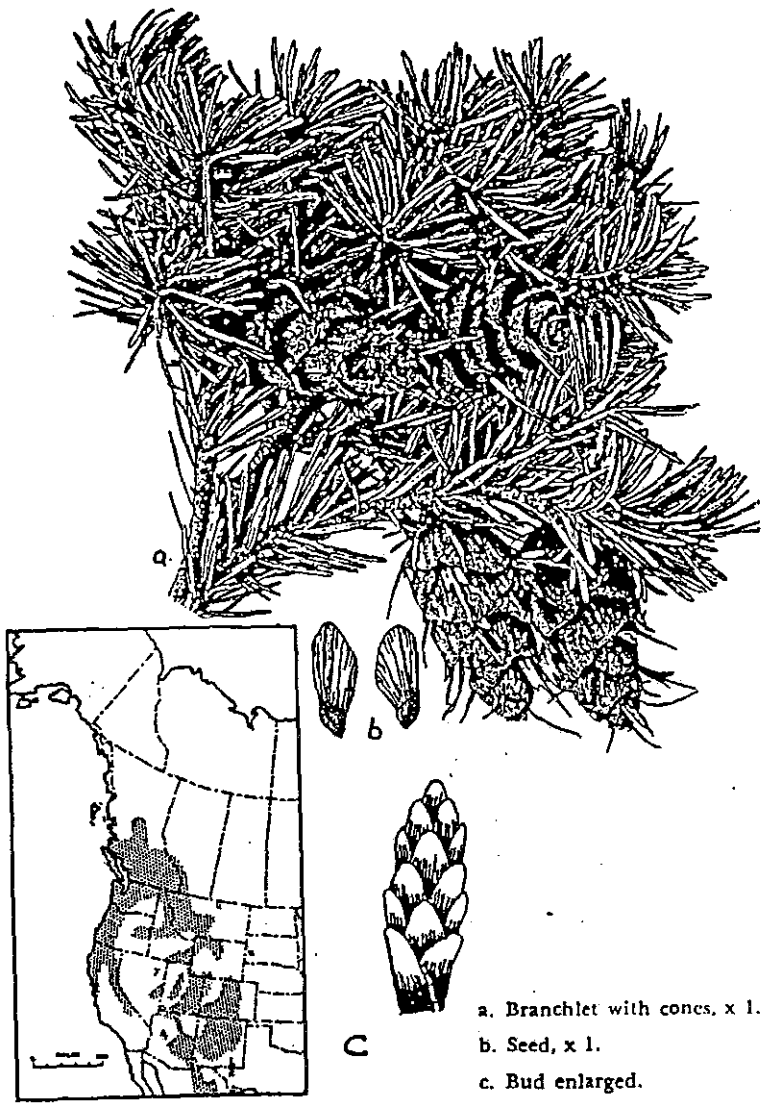
BARK. Thin, gray, smooth except for numerous resin blisters on young trees; becoming shallowly fissured.

WOOD. Similar to balsam fir but little used except for fuel.

SILVICAL CHARACTERS. Tolerant (of its associates, only Engelmann spruce and mountain hemlock are more so); growth not rapid; reproduction abundant and vigorous; shallow root system; lower branches sometimes taking root.

HABITAT. Canadian and Hudsonian zones; growing from 3,500 feet to timber line in the north and from 10,500 feet to timber line in the south; in cool, moist sites; commonly with Engelmann spruce, lodgepole, whitebark, limber, or bristlecone pines, alpine larch, cork fir, and sapen.

GENERAL. Corkbark fir *A. lasiocarpa* var. *arizonica* (Merr.) Lemm. of New Mexico, Arizona, and southern Colorado, differs from alpine fir in having soft, corky, yellow-white to ash-gray trunk bark.



a. Branchlet with cones, x 1.
b. Seed, x 1.
c. Bud enlarged.

PINACEAE

DOUGLAS-FIR

Pseudotsuga taxifolia (Poir.) Britt. (*Pseudotsuga menziesii* Franco)

HABIT. A large evergreen tree attaining a height of over 300 feet on the west coast and 130 feet in the Rocky Mountains; compact, pyramidal crown, with irregularly disposed branches.

LEAVES. Linear, single, more or less flattened, blunt to pointed, spirally arranged, and petiolate; ¾–1¼ inches long; grooved above and stomatiferous below; persistent 5–8 years or longer.

FLOWERS. Monoecious; male orange-red; female red-green.

FRUIT. Pendent, woody cones; 2–4½ inches long, oblong-ovoid, maturing in one season; scales thin, rigid, rounded, much shorter than their long, exserted, 3-lobed bracts. Seed: ¼ inch long, with large, rounded, terminal wing.

TWIGS. Slender, pubescent, orange-brown, becoming gray-brown. Winter buds: ¼ inch long, characteristically long, conical, sharp-pointed, lustrous, brown.

BARK. Smooth, gray-brown and with resin blisters on young trees; becoming very thick (6–24 inches), rough, with red-brown ridges separated by deep furrows.

WOOD. Highly variable from yellowish, narrow-ringed, moderately light and soft, to red-brown, wide-ringed, with weak spring wood and very dense summer wood. This tree produces more timber than any other species.

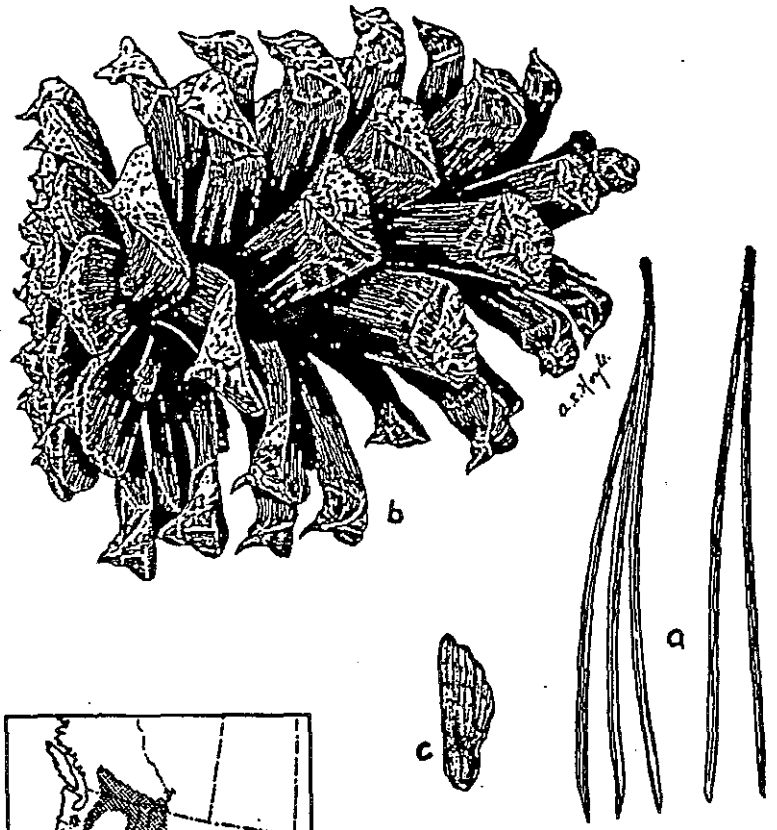
SILVICAL CHARACTERS. Intermediate in tolerance; reproduction abundant and vigorous; well developed, wide-spreading lateral root system; attaining great age.

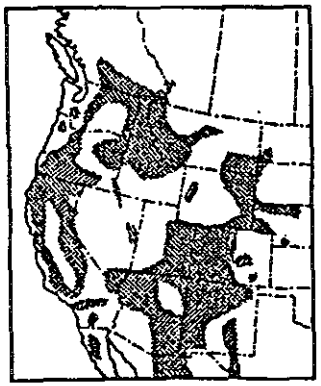
HABITAT. Sea level to 11,000 feet; adapted to variety of soils but best on moist, deep, porous soils of northern exposure; will endure considerable drought; in pure stands or mixed with Rocky Mountain conifers.

GENERAL. The check list assigns Douglas-fir the name *P. menziesii;* this author believes this was unwise and maintains the name *P. taxifolia.* European taxonomists have separated this species into 11 species; however this view is not commonly accepted in North America. The Rocky Mountain form is recognized as the separate geographical variety *glauca* (Mayr) Sudw.

* * *

The bigcone Douglas-fir *Pseudotsuga macrocarpa* (Vasey) Mayr, of Southern California is distinguished by its larger fruit (4–6½ inches long) with bracts only slightly longer than the thick, stiff cone scales.





a. Leaf bundles, x ½.
b. Mature cone, x 1.
c. Seed, x 1.

PONDEROSA PINE. WESTERN YELLOW PINE

Pinus ponderosa Laws.

HABIT. A tree 150–180 feet high and 3–4 feet in diameter (max. 232 by 8 feet on Pacific Coast); bole symmetrical, clear; crown short, conical or flat-topped.

LEAVES. In fascicles of 3, or 2 and 3 (rarely from 1–5); 3–11 inches long (mostly 4–7 inches); stout; dark to yellow-green; persistent 2–7 years (usually 4–6 years); cross section shows 2–5 resin ducts; basal sheath ¼–¾ inch long, persistent.

FLOWERS. Male yellow; female red, clustered or paired.

FRUIT. Subsessile; 2½–6 inches long; ovoid; open at maturity; basal scales remaining attached to twig when cones shed; scales thin, armed with short prickles. Seed: ¼ inch long; brown-purple, often mottled; wing 1 inch long.

TWIGS. Stout; orange-colored; turpentine odor when bruised. Winter buds: about ½ inch long; often resinous.

BARK. Black and furrowed on young trees; on old trunks 2–4 inches thick; yellow-brown to cinnamon-red; in large, flat plates.

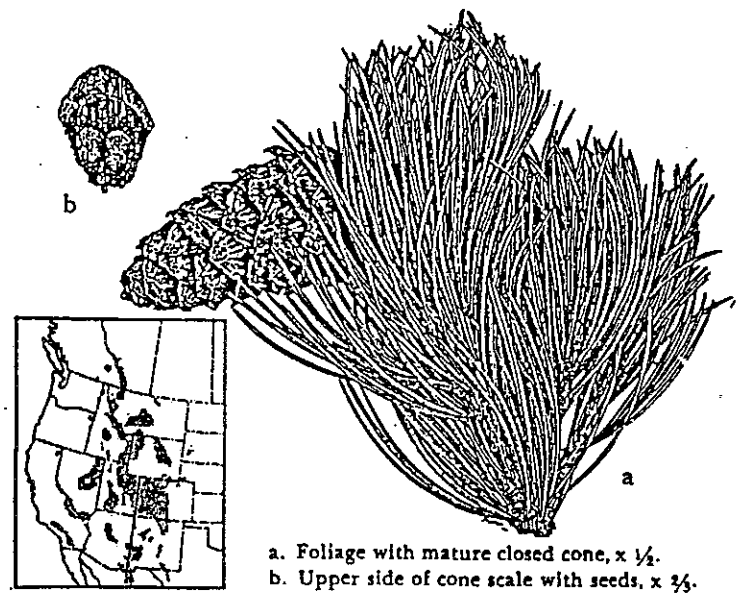
WOOD. Very important; rather light and soft; sapwood very thick with properties of white pine; heartwood light brown; uses include construction, planing mill products, ties, etc.

SILVICAL CHARACTERS. Intolerant; growth slow; maturity in 350–500 years (extreme age 660 years); reproduction vigorous; long taproot; fire and bark beetles cause damage.

HABITAT. Transition zone; large altitudinal range, from 2,000–8,000 feet; exceedingly drouth resistant; in open pure stands or more commonly the most abundant tree in mixed coniferous stands.

GENERAL. The Rocky Mountain variety is designated *P. ponderosa* var. *scopulorum* Engelm. Arizona pine, *P. ponderosa* var. *arizonica* (Engelm.) Shaw, of southern New Mexico, Arizona, and northern Mexico, differs in having needles in fascicles of 5 and cones less than 3½ inches long.

LIMBER PINE



a. Foliage with mature closed cone, x ½.
b. Upper side of cone scale with seeds, x ⅔.

PINACEAE

LIMBER PINE

Pinus flexilis James

HABIT. A tree 25–50 feet high (max. 85 by 6⅓ feet); crown broad, open, with large, plumelike, often drooping branches.

LEAVES. In fascicles of 5; 1½–3 inches long; stout; rigid; dark green; persistent 5–6 years; sheath deciduous; margins with minute teeth; marked on all sides by rows of stomata.

FLOWERS. Male red; female clustered, red-purple.

FRUIT. Cones short-stalked; 3–10 inches long; subcylindrical; open at maturity; scales greatly thickened and often slightly reflexed, with terminal unarmed umbo. Seed: ⅓–½ inch long; wingless; thick, light brown shell. The variety *reflexa* Engelm. (*P. strobiformis* Engelm.) of the Mexican border has strongly reflexed cone scales.

TWIGS. Stout and tough; smooth and silver-white or gray. Winter buds: ⅓–½ inch long; broad ovoid and pointed.

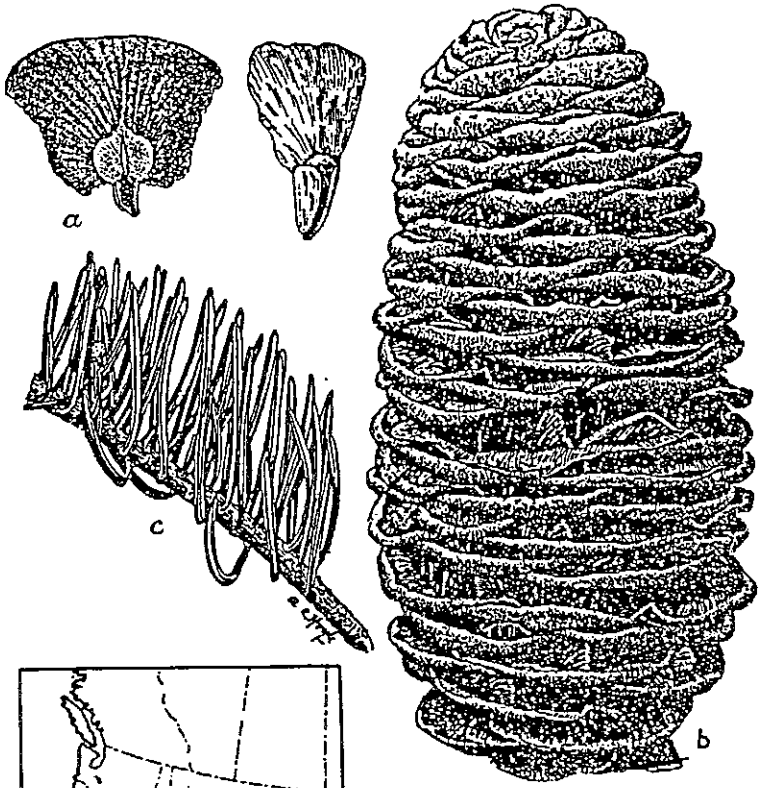
BARK. Characteristically thin, smooth, white-gray.

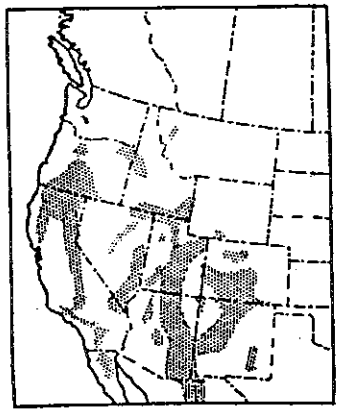
WOOD. Unimportant; moderately light and soft; close-grained; used locally for mine props, railroad ties, etc.

SILVICAL CHARACTERS. Very intolerant; growth slow; maturity reached in 200–300 years; tree very windfirm with taproot; fire, blister rust, and bark beetles cause damage.

HABITAT. Upper Sonoran to Hudsonian zones; altitudinal range from 4,000–11,500 feet; adapted to wide variety of sites, but typical of summits and rocky foothills.

* * *





a. Cone scale and seed, x 1.

b. Mature cone, x 1.

c. Lower crown needles, x ¾.

WHITE FIR

Abies concolor (Gord. & Glend.) Lindl.

HABIT. A tree 120–150 feet high and 3–4 feet in diameter (max. 200 by 6 feet); a dense conelike crown with heavily foliaged, long-persisting, short branches.

LEAVES. On lower branches 2–3 inches long, flat, straight, and acute at apex; on fertile branches, or on old trees, ¾–1½ inches long, thick, keeled above, usually curved, acute or rarely noticed at apex; silver-blue to silver-green; crowded; more or less obscurely 2-ranked or extending from all sides of twig; stomatiferous above and below.

FLOWERS. Male rose to dark red; female greenish.

FRUIT. 3–5 inches long, oblong, bright yellow to olive-green or purple; scales much broader than long, and twice as long as short-tipped bracts. Seed: ⅓–½ inch long, yellow-brown with rose-tinted broad wing.

TWIGS. Moderately stout, smooth, yellow-green to brown-green and ultimately gray-brown. Winter buds: subglobose, resin-covered, ⅛–¼ inch long, yellow-brown.

BARK. Thin, gray, smooth except for numerous resin blisters on young trees; becoming 4–7 inches thick, ash-gray, hard and horny, with deep furrows and wide ridges.

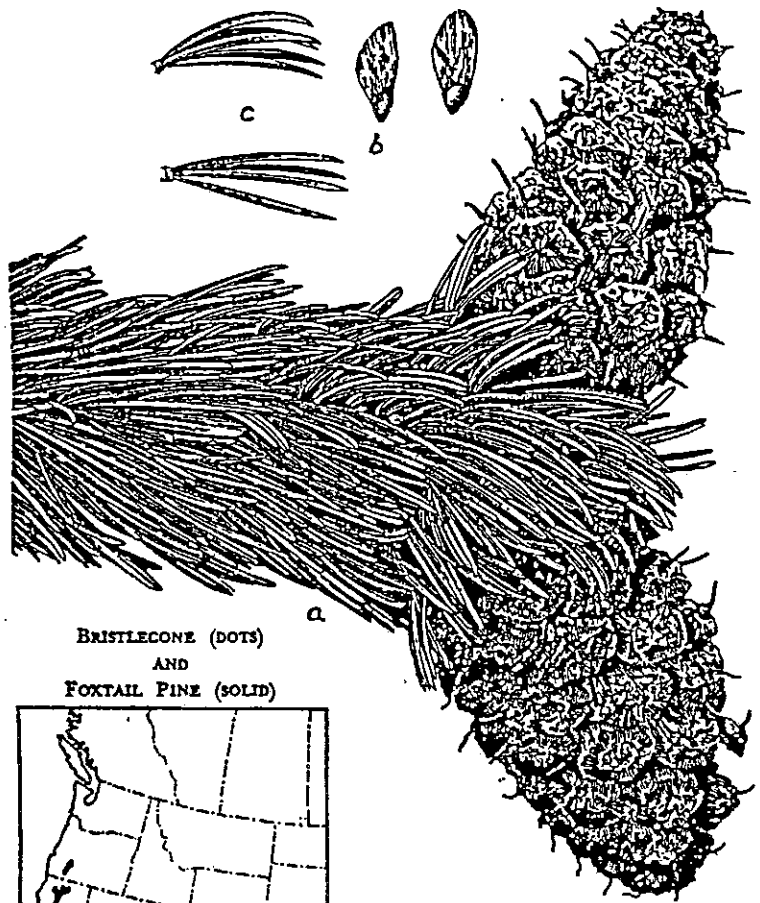
WOOD. Similar to balsam fir; used for lumber, pulp, boxes and novelties.

SILVICAL CHARACTERS. Tolerant, although less so than alpine fir; growth moderately rapid, maturity being reached in about 300 years; reproduction generally abundant and aggressive; root system normally shallow.

HABITAT. Transition and Canadian zones; altitudinal range from 6,000–11,000 feet; requires less moisture than other western firs, existing surprisingly well on poor, dry sites; seldom in pure stands, usually with ponderosa and limber pine, Douglas-fir, alpine fir, Engelmann spruce, and aspen.

GENERAL. The Pacific white fir, considered a variety by some authors, [*A. concolor* var. *lowiana* (Gord.) Lemm.] of Oregon and California differs from the species in having smaller buds and somewhat longer needles which are more pectinately arranged.

BRISTLECONE PINE



BRISTLECONE (DOTS)
AND
FOXTAIL PINE (SOLID)

a. Foliage and cones, x ¼.
b. Seed, x ¾.
c. Leaf bundles, x ¼.

[12]

PINACEAE

BRISTLECONE PINE

Pinus aristata Engelm.

HABIT. A subalpine tree 30–40 feet high and 1–2 feet in diameter (max. 60 by 3 feet); bole short, stocky, and commonly malformed; crown dense, irregular, bushy in appearance, and frequently clothing the stem nearly to the ground.

LEAVES. In fascicles of 5; 1–1½ inches long; stout and curved; deep green; persistent for 10–17 years; in dense, often appressed, clusters; sheath deciduous; lustrous on back, marked on lower or ventral surfaces by numerous rows of stomata; usually showing conspicuous whitish exudations of resin.

FLOWERS. Male dark orange-red; female purple.

FRUIT. Cones short-stalked, 3–3½ inches long; ovoid-oblong; open at maturity; scales thick, with dark chocolate-brown apophysis; umbo dorsal, with long, bristle-like, fragile, incurved prickle. Seed: ¼ inch long; with long terminal wing.

TWIGS. Stout; orange-colored, becoming nearly black; long tufts of foliage at ends. Winter buds: ⅓ inch long, brown.

BARK. Thin, smooth, and gray-white on young stems; ½–¾ inch thick on mature trunks, red-brown and furrowed.

WOOD. Unimportant; moderately soft; heartwood pale red-brown; used locally for fuel and mine props.

SILVICAL CHARACTERS. Very intolerant; growth slow; maturity reached in 200–250 years, attains great age, some trees over 2,000 years old and possibly the oldest living organism; reproduction sparse and scattered; tree windfirm.

HABITAT. From typical Hudsonian to Transition zones; altitudinal range from 7,500–10,800 feet; typical of exposed sites; usually in mixture with limber pine, fir, and spruce.

* * *

SALICACEAE

QUAKING ASPEN. POPLAR

Populus tremuloides Michx.

HABIT. A small tree 50–60 feet high and 1–2 feet in diameter; loose, rounded crown with slender branches.

LEAVES. Semiorbicular or broadly ovate; 1½–3 inches in diameter; yellow-green; apex acute; base rounded; finely crenate-serrate with glandular teeth; thin and firm; glabrous; petioles flattened, 1½–3 inches long.

FRUIT. Capsules narrowly conical; ¼ inch long; curved; 2-valved; gray-hairy. Seed; light brown, ½₂ inch long.

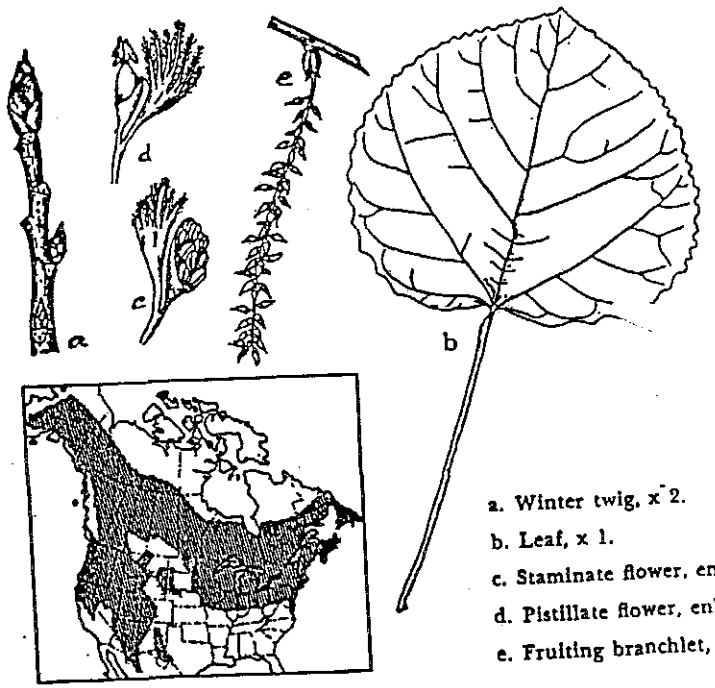
TWIGS. Slender; round; bright red-brown and lustrous, becoming gray. Winter buds; terminal ¼–½ inch long, conical, sharp-pointed, red-brown, sometimes slightly resinous.

BARK. Smooth; green-white to cream-colored.

SILVICAL CHARACTERS. Canadian and Hudsonian zones; reproducing vigorously on cut-over or burned-over areas and forming a protective canopy for more tolerant species.

* * *

QUAKING ASPEN



a. Winter twig, x 2.
b. Leaf, x 1.
c. Staminate flower, enlarged.
d. Pistillate flower, enlarged.
e. Fruiting branchlet, x ½.

APPENDIX I

Krebs Plot Summary Protocol

Conduct Krebs Plots

Based on the results of the winter track surveys, Krebs plots (Krebs et al. 1987) (5.08 cm [2 in] x 305 cm [120 in] long rectangles [a fully extended bungee cord held by 2 average-sized fingers!]) will be run by placing 10 temporary plots at 30-m intervals along a pair of 120-m parallel transects offset by 30 m in three successional stages – sapling, pole, and mature for two principal forest types — 1) Englemann spruce/subalpine fir, and 2) lodgepole pine mixed with spruce fir (Weaver 1997).

These forest types will be sampled proportional to the area of each type/successional stage and from areas with above average number of snowshoe hare tracks (mean determined from winter track surveys and starting with the highest) and areas with nearby denning habitat (the closest having highest priority). Hence, two factors will need to be linked in order to select areas for the Krebs plots.

A more detailed protocol for this work will be developed after the winter track surveys are complete and when the location of the plots can be determined. The plan is to conduct the plots in areas that have the two factors described above and in areas where high potential habitat exists but where track surveys were absent. Additional field inspections will be conducted during the summer to identify these high potential habitats that were not "track surveyed." Also, the number of plots needed (adequate sample size) for each forest type/successional stage will need to be estimated.

APPENDIX J

Yukon
Renewable Resources
Box 2703, Whitehorse, Yukon Y1A 2C6

fw5/HJ:g:trnsplnt
Our File:
Your File:

1997 September 10

Jim Olterman
Sr. Wildlife Biologist
PO Box 806
Dolores, Co 81323

Dear Mr. Olterman:

Re: Introduction of Lynx and Wolverine to Colorado

There is a current ban on the export of live lynx from the Yukon, however, we have made exceptions for conservation reasons (i.e. reintroduction). We would require a formal request from your agency to take before the Yukon Fish and Wildlife Management Board for their recommendation. The ban is in place because of local concerns that successful rearing of lynx in captivity could have a long term detrimental effect on the wild fur prices. In your request, we would need assurances that lynx from the Yukon would indeed be released to the wild and none will be sold or transferred to game farms, zoos, or fur farms. There is no such export ban on wolverine.

Specifically in response questions posed in your August 27, 1997 letter:

Our agency would approve the export of both species with the conditions noted above for lynx. As lynx is listed under Appendix II of CITES, a federal permit is required but that can be issued by our agency as well. Only an export permit is required from this end. We impose a veterinary inspection prior to export to ensure the animal is healthy and uninjured. We will only allow shipment via air and shipping crates must be constructed in accordance with the International Air Transport Association (IATA) regulations.

Both species are found in relative abundance throughout the Yukon and are easily live trapped. Only licensed trappers would be allowed to live trap. As noted above, we subject each animal to a veterinary inspection. We could certainly accommodate your request for 100 lynx per year from a population perspective, but it would be difficult logistically. Similarly with wolverine. I suspect you will have to involve more than one jurisdiction or spread your project over a longer time frame.

.../2

APPENDIX J (Continued)

Jim Olterman - Introduction of Lynx and Wolverine to Colorado
1997 September 10
Page 2

My estimates may be dated, but I believe trappers would be expecting in the neighborhood of $400.00 for male lynx and $800.00 for female lynx. Wolverine would be closer to $1000.00 and $1500.00 for male and female respectively. All costs are in US dollars. Over and above this cost would be veterinary fees. The animals would be shipped collect. There would be no recoverable costs incurred by the Fish and Wildlife Branch.

Your best source of information regarding the release of lynx would be Dr. Rainer Brocke of the State University of New York, College of Environmental Science and Forestry, Syracuse, New York 13210. In the late 1980's and early 1990's the Yukon Fish and Wildlife Branch cooperated with SUNY on a lynx reintroduction project in the Adirondack Mountains. I am not as familiar with wolverine transplants but I believe it was tried in Michigan a number of years ago. More recently, the Province of Quebec was also considering reintroducing wolverine. I am not aware if they went ahead with the project.

If you want to obtain lynx and wolverine from the Yukon during the 1997/98 trapping season, I suggest you contact Harvey Jessup, our Wildlife Harvest Manager. He can provide you with more information about process. He can be reached at tel. 403 667 5767, fax 403 393 6205 or e-mail harvey.jessup@gov.yk.ca.

I trust the above addresses your questions related to obtaining live lynx and wolverine from the Yukon.

Sincerely,

Don Toews
Acting Director
Fish and Wildlife Branch

APPENDIX J (Continued)

Alberta
ENVIRONMENTAL PROTECTION

Natural Resources Service
Wildlife Management Division
Mailing Address: Main Floor, North Tower, Petroleum Plaza, 9945-108 Street, Edmonton, Alberta, Canada T5K 2G6
Location Address: 4th Floor, Bramalea Building, 9920-108 Street, Edmonton, Alberta, Canada 403/427-6750, FAX: 403/422-9557

4263-001

October 8, 1997

Mr. Jim Olterman
Sr. Wildlife Biologist
PO Box 806
Dolores, CO 81323

Dear Mr. Olterman:

Your letter of August 27, 1997 concerning the possibility of obtaining lynx and wolverine from Alberta for reintroduction to Colorado has been referred to me.

Alberta would be willing to approve the capture and export of lynx from Alberta. However, wolverine are classified as a species that *may* be at risk in Alberta and we are not in a position to allow export of this species. From Alberta's perspective all that is required is approval from our agency (including approval of import permits that may be necessary) and the necessary possession and export permits for the animals. Export permits would consist of provincial export permits plus federal C.I.T.E.S. permits for this species. You would have to check with federal U.S. authorities to determine what requirements they have.

Lynx would be available through registered trappers in Alberta during the regular trapping season (December and January) and within prescribed quotas. This is the avenue for collection that would be acceptable and has been used in the past. A copy of the 1997 Alberta Guide to Trapping Regulations is enclosed for your information. I am advised that there are some experienced live lynx trappers in Alberta that have the holding facilities to handle them. It is difficult to estimate the cost per animal as this would depend on what the trapper is expected to do beyond capture of the animal. Perhaps $300 to $500 per animal would not be out of line.

With respect to the best method of release, I suggest you contact the State University of New York (contact - Rainer Block). They obtained lynx from the Yukon Territory for a project to reintroduce lynx to New York several years ago (refer also to Trans. North Amer. Wildl. Nat. Resour. Conf. 55:590-598). A copy of a brochure on this project is enclosed for your information.

.../2

APPENDIX J (Continued)

If you decide to proceed with a formal request to receive lynx from Alberta, I would ask that you direct that request to me. I will then identify appropriate contacts for the operation. In the meantime, you may wish to contact Mr. Ted Ganske, President, Alberta Trappers' Association, #2, 9919 - 106 Street, Westlock, Alberta T7P 2K1, regarding the potential involvement of trappers in this project.

I wish you well in your reintroduction program.

Sincerely,

B J Markham

Brent J. Markham
Acting Director
Wildlife Management Division

Enclosure

APPENDIX J (Continued)

BRITISH COLUMBIA

October 16, 1997 Our File: 78800-01

Department of Natural Resources
Division of Wildlife
P.O. Box 806
Dolores, Colorado
81323

Attention: Jim Alterman

Dear Jim:

This is in reply to your letter requesting information on collecting/purchasing live lynx and wolverine from British Columbia for relocation projects in Colorado. I will answer the questions in your letter in the sequence they have been asked, however I must advise you that for approval for this project you must submit a request to the Director of Wildlife, who is located in Victoria. Lynx and/or wolverine would have to be captured in the northern part of our province and in this regard I have passed your letter onto those individuals responsible for managing wildlife where animals could potentially be collected.

I'm not sure that British Columbia could supply the 60 wolverine, however between Alberta and the Yukon you may be able to get the number you require. Currently hare densities are recovering or high and lynx numbers should be good to increasing. You will have to contact the biologist recommended below for a definitive answer of numbers and logistics.

1. To facilitate transborder co-operation and to assist with the expansion and conservation of lynx and wolverine in North America, I do believe that British Columbia, and possibly Alberta would be interested in assisting you with your program. However, the actual number of animals available and location as to where they would be collected would have to be discussed in detail before such a project could proceed.

   To develop your program you should discuss your interests with the Regional Wildlife Biologist from where animals would be collected. Preliminary discussion should probably commence with Fred Harper, Regional Wildlife Section Head, Southern Interior Region, 1259 Dalhousie Drive, Kamloops, B.C. V2C 5Z5 (250-371-6265), John Youds, Regional Wildlife Section Head, Cariboo Region, Ste 400-640 Borland Street, Williams Lk, B.C. V2G 4T1 (250-398-4563) and Douglas Heard, Regional Wildlife Section Head, Omineca Region, 3rd Floor, 1011 4th Ave., Prince George, B.C. V2L 3H9 (250-565-6425).

Ministry of Environment, Lands and Parks

BC Environment & Lands
Kootenay Region

Mailing/Location Address:
205-Industrial Rd. G,
Cranbrook, BC V1C 6H3

Environment: (250) 489-8540
Lands: (250) 489-8510
Facsimile: (250) 489-8506

Conservation Service (250) 489-8570

APPENDIX J (Continued)

To obtain approval for the transplant you will be required to write a letter to the Director of Wildlife, Nancy Bircher, P.O Box 9374 Stn. Prov. Gov., Victoria, B.C. V8W 9M4 (250-387-9731) outlining your needs, methods, location for release, EIS if required and completed, time frame, budget you have assigned to the project and contact persons.

2. Your best bet would be to have registered trappers live capture both lynx and wolverine. BC Environment would likely assign suitable trappers with an annual quota of animals they can live capture for transport.

   My experience with the fisher project, indicates this is a suitable method as long as there is a qualified individual in B.C. who will receive the captured animals and care for them until they are to be transported. It is also important to ensure that appropriate capture and humane handling techniques have been taught to the trappers. These issues can be worked out with Regional staff and the Ministry veterinarian if the project is approved.

3. We are currently paying $200 (CDN $) for a live fisher to the trapper. However the total cost of handling, care and maintenance is approximately $560. I would suspect it would cost at least $500 per lynx or wolverine another, $1000 for the other expenses incurred before they can be shipped south. This would cover cages, food, transportation, vet supplies, contract to the receiver/handler, etc.

4. I'm not sure the best way to handle the release of lynx, however it may be worthwhile investigating the literature for other transplants that have occurred elsewhere in North America. I believe lynx transplants have occurred in Maine and West Virginia. My own personal feeling is that you should try to work with young animals if possible to reduce movement, release in areas you know have excellent hare densities, other features lynx like (downed woody debris, high elevation with little competition with coyotes and bobcat if possible) and reasonably large contiguous suitable habitat not impacted severely by human activity. Both hard and soft releases should be experimented with initially, as should the time of year for release.

   Our trapping season commences on November 15 and runs in many areas to February 15. My gut feeling is that you should try to release them at the end of the season, just prior to spring and before any pregnant females produce kittens. However, you should make sure that these animals are in good condition (almost fat), as the first month to six weeks will be hardest in respect to survival. A pre-winter release (December) may also work as long as they are released into an area that has a bunch of hares. Also have a healthy budget for collaring and monitoring.

   I would cage these animals individually, both lynx and wolverine are solitary animals unless they are females in the company of kittens/kits or breeding pairs (which is short in union).

5. Hopefully I have answered this question above.

APPENDIX J(Continued)

Unfortunately the Kootenay Region will not be able to supply you with animals, primarily because we are at the lower limit of lynx and wolverine in B.C. but also because we are in the process of recovering lynx populations ourselves.

If you require any additional information please do not hesitate to contact me though, I suspect all your dealing will be with the individuals whose names I have given you. I'm extremely interested in your project and hope that British Columbia can help you in the future.

Good luck and see you in Banff next spring.

Yours truly,

H. Mackenzie

for Anna Fontana, RPBio
Wildlife Biologist

cc Nancy Bircher
Fred Harper
John Youds
Douglas Heard

APPENDIX J (Continued)

To: <jim.olterman@state.co.us>
Cc: <wayner@fishgame.state.ak.us>,<Wayne>
Bcc:
From: KenTa@fishgame.state.ak.us (Taylor
Subject: Lynx and Wolverine
Date: Tuesday, September 2, 1997 9:18:00 MDT
Attach:
Certify: N
Priority: Normal
Defer until:
Expires:
Forwarded by:

Jim,

Wayne is on leave this week. Both he and I will be at the IAFWA conference next week in Scottsdale. If anyone associated with your interest in establishing wolverine and lynx populations in Colorado will be there we could discuss it then.

Our agency would likely approve capture and export of both species, however your numbers may be a bit unrealistic. Neither is easily caught. A large portion of wolverine trapped are caught with 330 conibears. Purchase of either species from trappers would be logistically very difficult. Wolverines could be captured using standard helicopter darting techniques which might prove most cost effective. Lynx are going to be difficult as previous capture for telemetry studies has shown.

I suspect Wayne will ask me to follow up on your request when I see him, so please use me as your contact on this project. We have several excellent furbearer biologists who can help with details and questions as needed.

Ken Taylor
Deputy Director - Alaska